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Avocado Fruit Abnormalities and Defects Revisited

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Occasionally an observant grower will note the presence of defective avocado fruit on a tree or in a harvested bin. At the packinghouse grading table, however, these defects are more obvious given the increased volume of fruit. In fact, Art Schroeder in 1953 suggested this approach for observing unusual fruit abnormalities. Abnormal fruit can occur in all varieties and has been discussed several times in the avocado literature (Blumenfeld and Gazit, 1974; Coit, 1928; Hodgson, 1935; Horne, 1929, 1934; Kadman et al., 1973; Platt, 1972; Schroeder, 1953; Tomer et al., 1980, Zamet, 1996).

What follows is a review of these descriptions with photographs from the 'Hass' variety depicting various fruit abnormalities and defects. As Schroeder suggested, the description of fruit abnormalities is of interest since "they (the abnormalities) may suggest certain aspects of the fruit morphology which are otherwise difficult to ascertain."

Fruit abnormalities and defects can either be induced by genetic factors such as somatic mutations that occur during cell division or can be induced by external factors such as water stress, wind or by insects. The expression of the defect, in particular, those arising from external factors will depend on the stage of fruit development at which it occurs. It is likely the vast majority of young affected fruit drop prior to harvest and thus go undetected, but some persist to harvest only to be downgraded at the packinghouse.

Abnormalities arising due to abnormal flowers.

Schroeder (1953), Kadman et al. (1973), Blumenfeld and Gazit (1974) and Tomer et al. (1980) have given the most thorough discussions of this type of aberrant fruit. This type of aberrant fruit can be classified into several different types as listed below:

- Cukes (seedless fruit)
- Double Fruit
    - Normal w/ external Cuke
    - Double Ovary
        - One normal seed; one cuke
        - 2 normal seeds
        - Double cuke
- Woody Fruit

Cukes are seedless fruit (Fig. 1). The cause of cuke formation is not known although there may be several reasons why this type of fruit occurs. It is believed that either an environmental or hormonal stimulus induces the development of the cuke. Zamet (1996) gives a thorough discussion of this topic. The remains of the ovary are normally evident and upon close examination one may observe the remnants of the degenerated ovule enclosed in what Tomer et al. (1980) called a “sheath”. The degeneration of the ovule is a result of a process termed “stenospermocarpy”.

There are several manifestations of “**double fruit**” (Figs. 2, 3). In some instances, there may be a normal shaped fruit with an external cuke attached (Fig. 2A). In other cases flowers may have two ovaries and give rise to either a fruit with a two fully developed seeds or one normal seed with the other ovary expressed as a cuke (Fig. 2B-C). Hodgson was the first to describe this phenomenon (1935) and considered the “true double fruit” (one with two normal seeds) as a rare event.

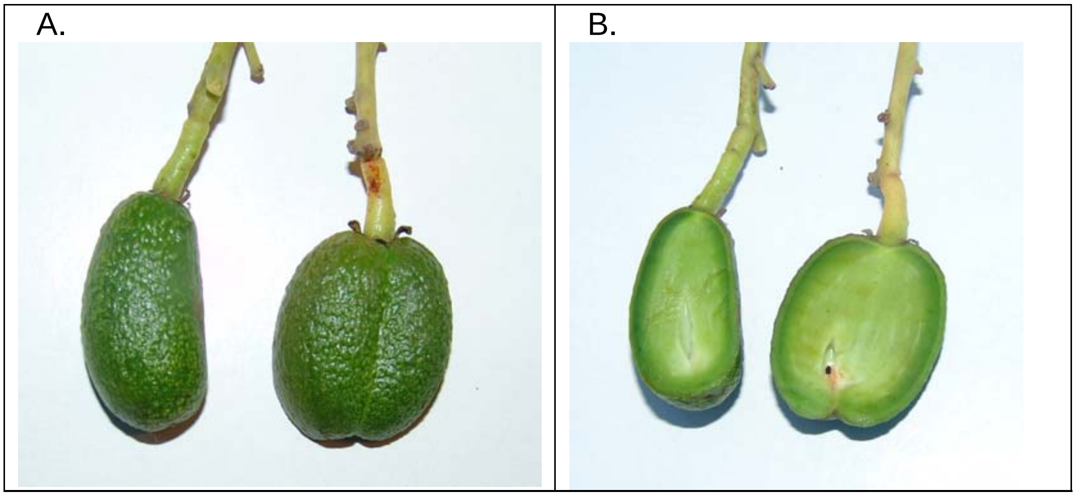


Figure 1. Examples of “cukes” or parthenocarpic ‘Hass’ fruit. A. Exterior view of fruit (left, single seeded fruit; right, double ovary fruit). B. Internal view of fruit. Note the “sheath” from the empty ovule. Fruit on right is the double fruit.

Schroeder (1953) described a type of double fruit in which there was a **longitudinal groove or ridge** with various degrees of development. He felt that this could represent the failure of the single carpel to completely develop around the ovule during development hence the evident line of fusion (Fig. 4 A).

Hodgson (1935) first described the occurrence of **woody fruits** which are actually composed of woody tissue (Fig. 4B). Schroeder (1953) describes this sort of aberrant fruit in this way: “Woody fruits actually are of wood structure; the normally soft parenchymatous ovary wall is displaced by a stem-like structure which may bear occasional small cauliflower-like appendages or excrescences suggestive of highly modified leaves. Such abnormal structures would suggest that the fruit may involve some stem tissue in its evolutionary development, although other evidence does not support this speculation.”

Abnormalities arising from sectorial chimeras

Hodgson was the first to discuss **sectorial chimeras** (1935) (Fig. 5A-F, Fig. 6). He theorized that a permanent change occurred during the development of the ovary wall and were technically known as “somatic mutations”. There are many types of sectorial chimeras. They typically extend from the apex to the base of the fruit and usually are manifested as longitudinal stripes of varied width, color and peel texture. Schroeder (1953) gives a further discussion of sectorial chimeras:

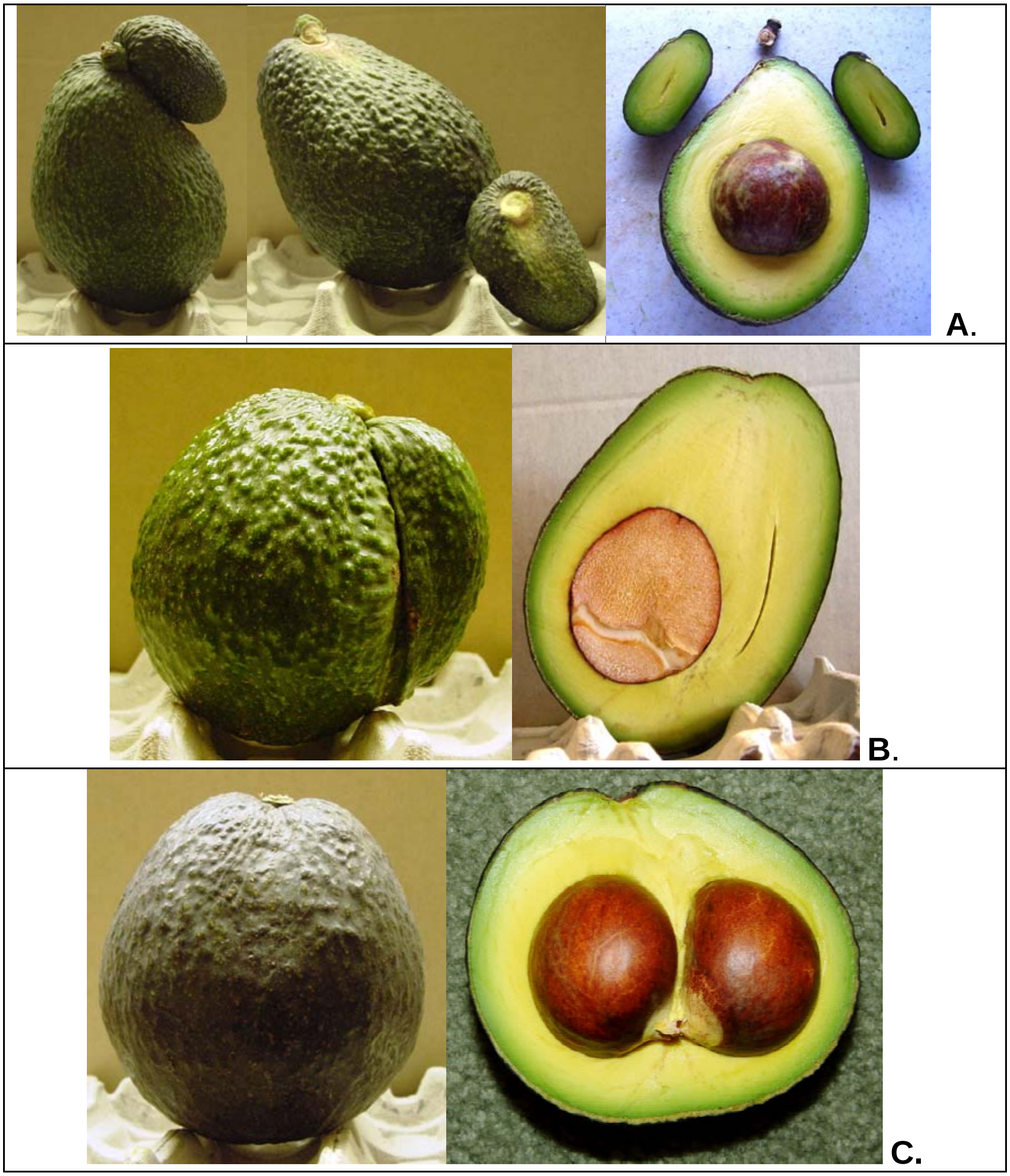


Figure 2. A. Double fruit resulting from the fusion of 2 carpels. The two separate fruit are only joined at the stem end. The “top fruit” is parthenocarpic (seedless) with only a sheath where seed would normally be (see right). B. Double fruit resulting from the presence of 2 ovaries. This fruit has 1 normal seed and one “sheath” containing a degenerated ovule. C. Double fruit which contains 2 fully developed seeds resulting from a flower which contained 2 ovaries.

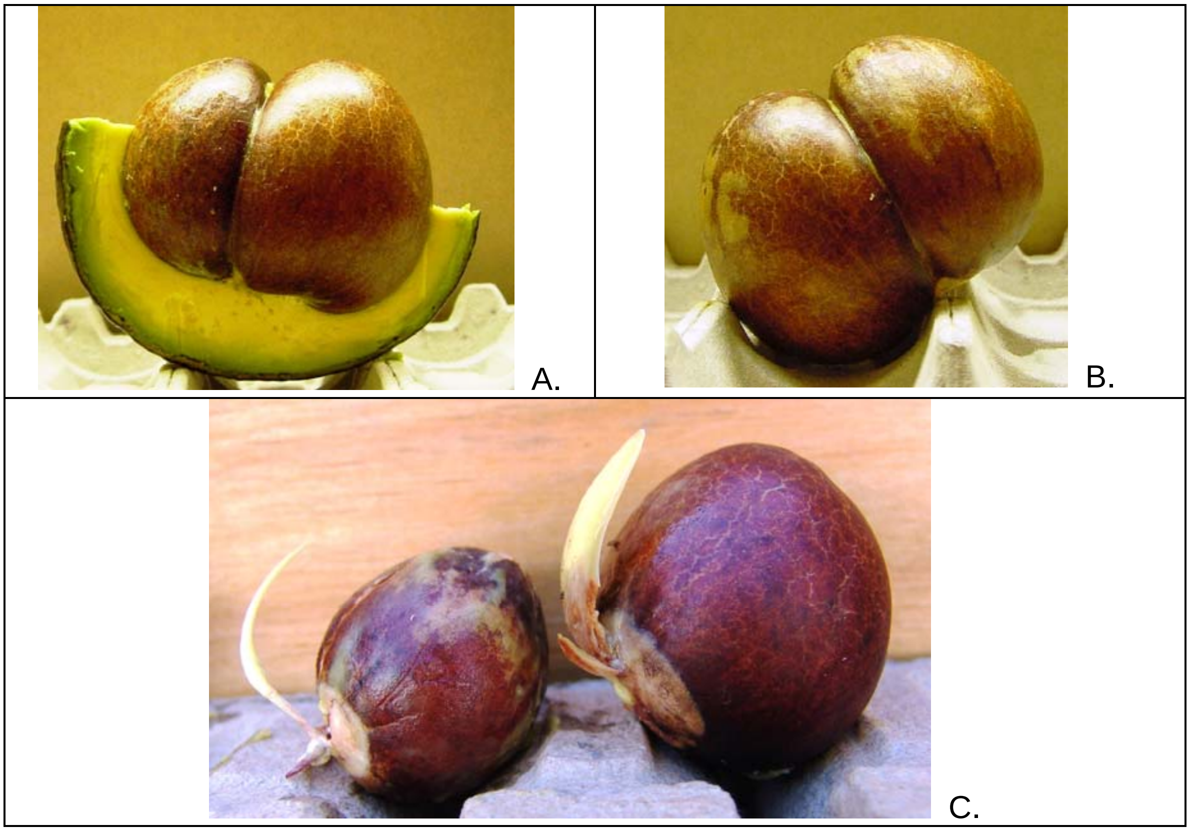


Figure 3. A. 'Hass' avocado fruit with 2 fully developed seeds. B. The same seeds in (A) but showing attachment at base of the seeds. C. Two examples of seeds from a double ovary flower, except in this case, one seed developed normally whereas in the other ovary, the ovule failed to develop normally giving rise to the type of fruit depicted in Figure 2B.

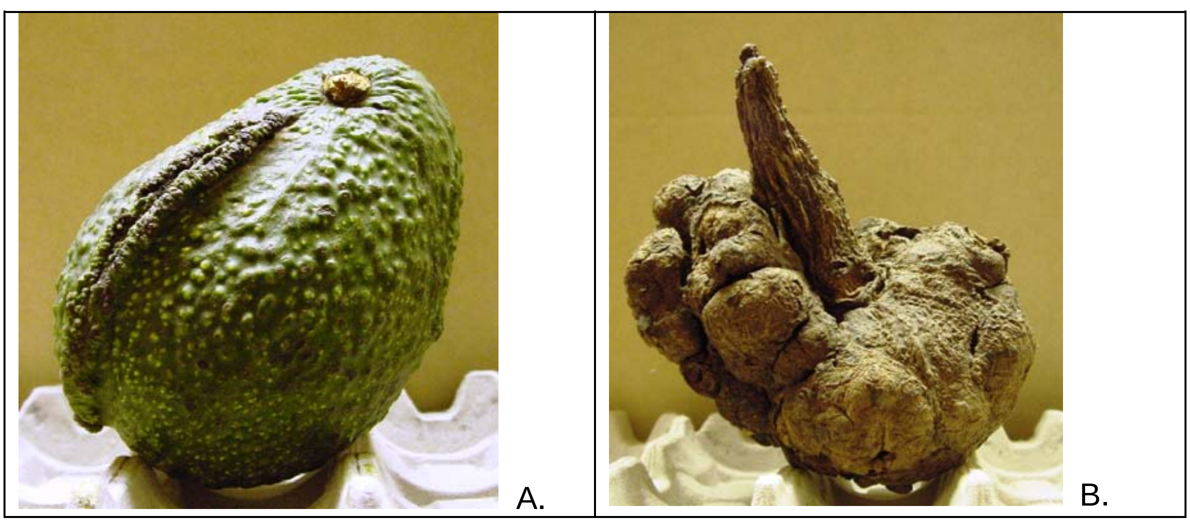


Figure 4. A. 'Hass' avocado fruit with a longitudinal ridge which C. Schroeder theorized was a result of incomplete closure of the carpel. Such fruit are often scarred on the ridge. B. A "woody" avocado 'Hass' avocado fruit.

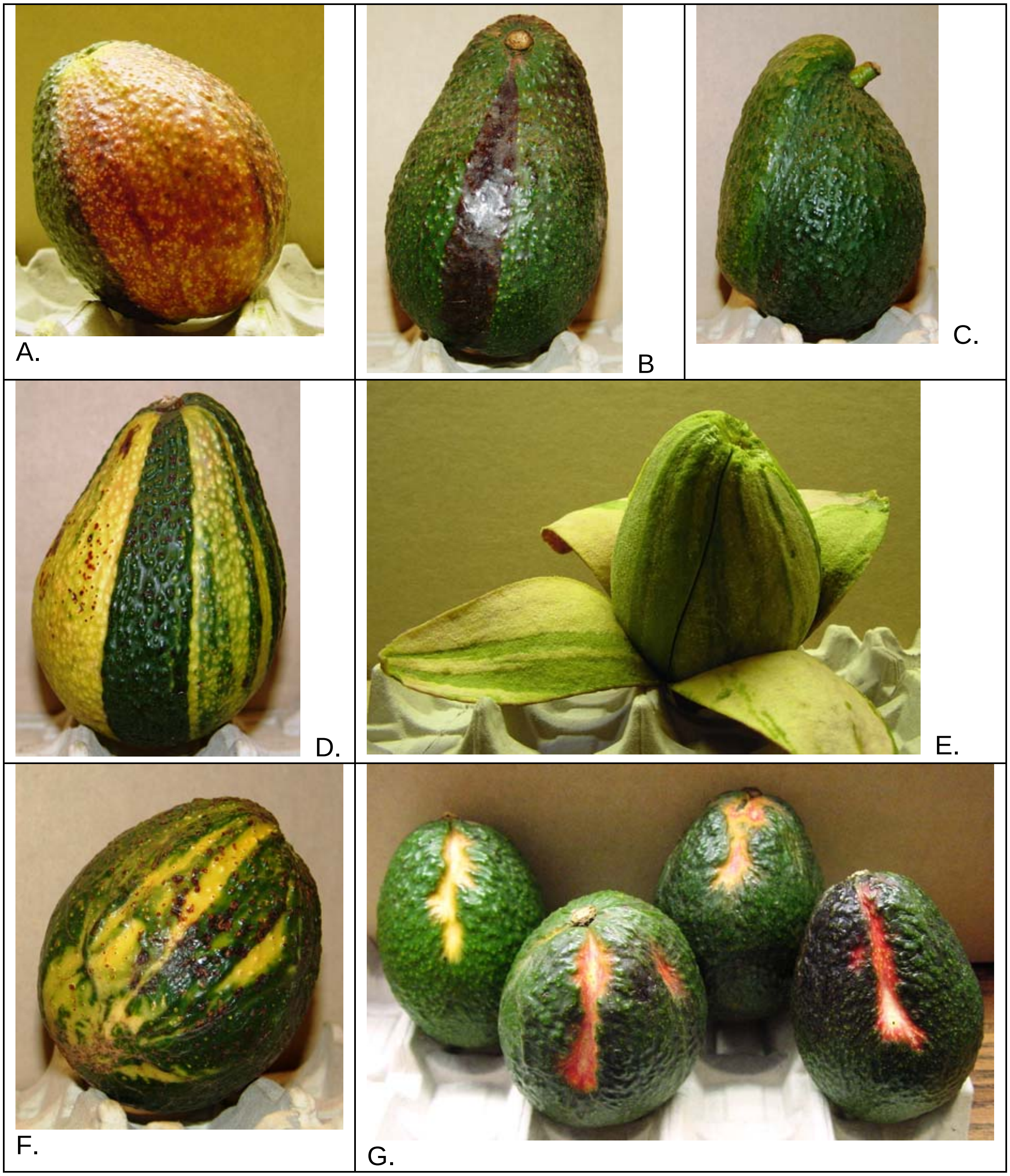


Figure 5. A. Sectorial chimera showing red coloration. B. Sectorial chimera showing dark coloration. C. A raised sectorial chimera. D. Mulltiple sectorial chimeras. E. Fruit peeled that had multiple sectorial chimeras similar to D. Note the difference in coloration extends into the flesh of the fruit. F. A sectorial chimera which could be confused with sunblotch viroid. G. Fruit infected with the sunblotch viroid. Note that the affected areas do not extend the length of the fruit and are depressed.

Such a chimera probably is the result of a mutation within a group of cells that occurs during the early development of the flower. The mutant tissue extends through a

> portion of the skin and involves only a few cell layers immediately beneath the epidermis. Such mutations frequently occur in the flower bud and are manifest only in the single fruit which develops from that flower, hence cannot be propagated. If the mutation takes place in woody tissue lower in the stem, which stem section will bear buds, flowers and fruits, then it sometimes is possible to propagate the bud sport if the mutated tissue is sufficient in extent and stable in character. Trees with such mutations or bud sports should be avoided when selecting buds for propagation of the variety. Bud sports generally are inferior compared to the original variety, although in some fruit plants certain bud mutations have proved to be of great importance.

Such mutations should not be confused with **sunblotch** (a viroid disease of avocado) which tends to be much more irregular in shape and normally does not extend the length of the fruit (Fig. 5G). Sunblotch symptoms on avocado fruit are also typically depressed and result from a modification and partial destruction of the vascular tissue in the fruit. The depressed areas of a sunblotch infected fruit are typically yellow or reddish in color.

Figure 6. Crook neck, another type of sectorial chimera.

Fruit defects arising from environmental stress

Crick-side. J. Eliot Coit (1928) was the first to describe this disorder (Fig. 7) and W. T. Horne provided a thorough description of crick-side in his 1934 publication entitled "Avocado Diseases in California":

> In crick-side the upper half of the fruit on the high side fails to grow normally, so that this part of the fruit becomes depressed. The part where deficiency of development occurs shows a crowding together of the prominences which make up the pebbling in the rough fruits. Affected flesh is denser and discolors more rapidly on exposure to the air, but otherwise appears about normal. Many crick-side fruits drop while small, and others are lost from a large black spot which develops in the depressed portion. Some affected fruits come to full maturity.

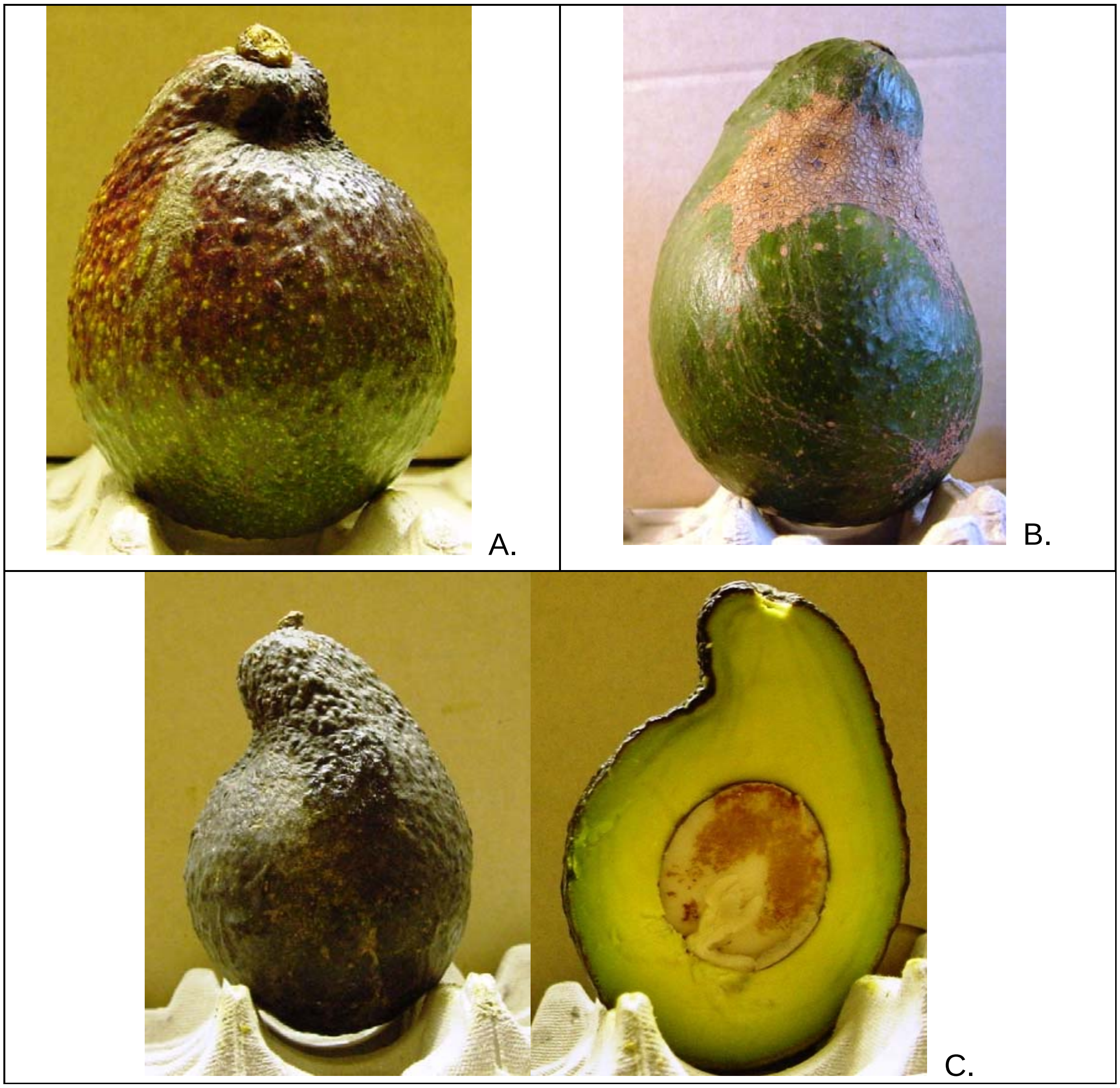


Figure 7. Examples of crick-side. A. Crick-side due to heat damage. B. Crick-side due to limb or insect feeding. C. A crick-side fruit due to an unknown cause, external and internal view of fruit cut longitudinally. Note the compressed nature of the flesh tissue in the portion of the “crick”.

It is believed that crick-side may arise due to water stress or high temperature during early fruit development or even may be due to insect feeding during early fruit development. Certain expressions of crick-side such as shown in Figure 7A and 7C could be confused with symptoms of boron deficiency (see Color Plate 14, Lahav and Whiley, 2002).

Another type of disorder which arises presumably from water stress is a disorder of the fruit pedicel (stem) termed **ring-neck** (Fig. 8). This disorder was first described afflicting the Fuerte variety by J. Elliot Coit in 1928. Horne (1934) provides a good description of this disorder:

> It is a blemish, usually on the fruit-stem or pedicel, consisting of irregular areas of superficial dried tissues which become more or less separated from the living tissue. It is particularly likely to affect the thickened segment of the pedicel next to the fruit. Sometimes a complete ring of surface tissue dies, separates from the pedicel, and

peels off, leaving a scar. The upper end of the pedicel …. is slightly fleshy and enlarged, and a small ring-neck spot sometimes occurs on it. Occasionally lesions which have somewhat the appearance of ring-neck develop on the fruit, and where extensive, may give it a grotesque appearance through curling up of the dead surface layer from the edges.

It was originally believed that ring-neck could be caused by a pathogen (Horne, 1934) however, early attempts failed to identify the causal organism. Toerien (1979) indicated that work in South Africa eliminated pathogen involvement in the development of this disorder (J. Darvas, personal communication cited by Toerien).

A.

B.

C.

Figure 8. Examples of ring-neck. A. Slight damage to the fruit pedicel. B. Note the peeling of the pedicel tissue. C. Note that only one fruit (left) is affected with ring-neck.

Intense sunlight and high temperatures during any stage of fruit development may cause damage to the fruit and result in misshapen fruit. **Sunburning** of immature and mature fruit on the tree may result in discolored peel and flesh damage below the affected peel (Fig. 9). In some cases the growth of the fruit at the point of injury may be affected. Additionally, when fruit are left exposed in the bin following harvest, postharvest sunburning can also occur. Postharvest heat damage can be quite severe and appears more scald-like in appearance.

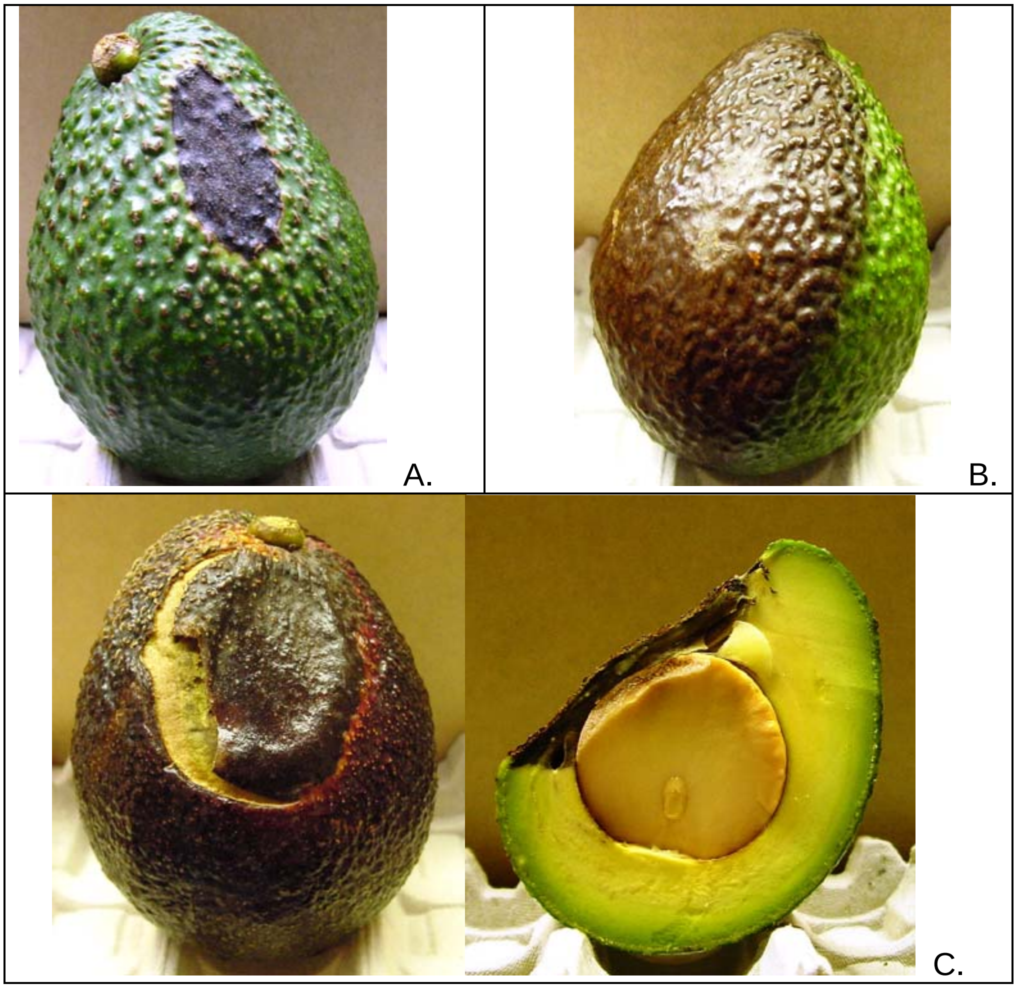
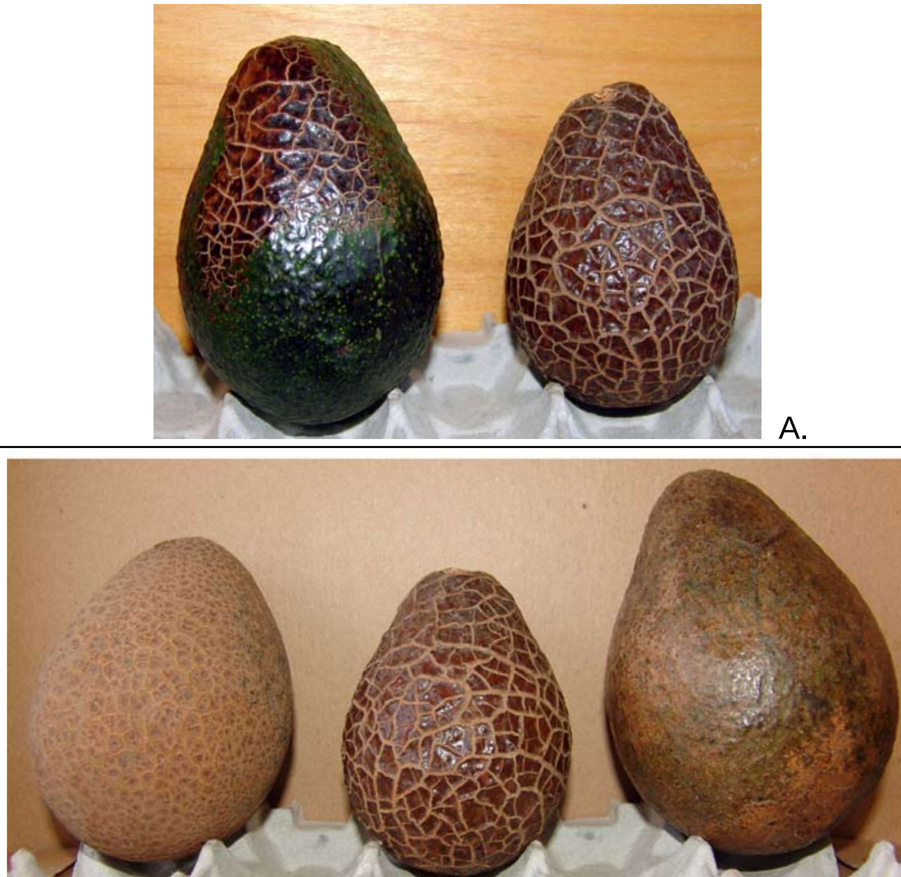


Figure 9. Examples of sunburned avocados. A. Sunburn that occurred when the fruit was on the tree. B. Sunburn that occurred after harvest, typically from the top of an uncovered bin. C. Severe sunburn (left) and a cut-away of fruit damaged to the seed due to sunburning.

Fruit defects arising from mechanical injury

There are a number of fruit symptoms that can occur to mechanical injury of the fruit. Horne (1929) described a disorder he termed **carapace spot** (Fig. 10) in this way:

> …the name "carapace spot" was chosen because of the resemblance to a turtle's back. This external blemish is corky and usually cracked into somewhat regular, angular divisions. The flesh under carapace spot is undamaged but exterior appearance is such that the fruit is reduced in grade.
>
> Slight rubbing or bruising of tender young fruit on leaves or stems appears to cause this corky growth to start. Fruit on trees exposed to strong winds are more apt to develop the trouble.



A.

B.

Figure 10. A. Examples of varying degree of carapace damage. B. A comparison of avocado thrips damage (left), carapace (middle) and greenhouse thrips damage (right).

It has been suggested that carapace can also arise after the fruit has been exposed to hot, dry, and windy conditions such as the “hamsin” that occur during early fruit development in Israel (E. Lahav, personal communication).

Abnormal fruit may also arise from other mechanical forces such as squeezing between two branches or rubbing against a branch (Fig. 11).

Fruit defects arising from insect injury

The occurrence of “papacados” is the extreme expression of avocado thrips damage. Many insects, however, can cause the fruit to be abnormal. **Insect injury or stings** during the early stages of fruit development probably are the cause of many types of irregular fruits. Injury of this nature is thought to cause some types of fasciation or flattened and irregular growth and woodiness of the fruit (Fig. 12).

A.

B.

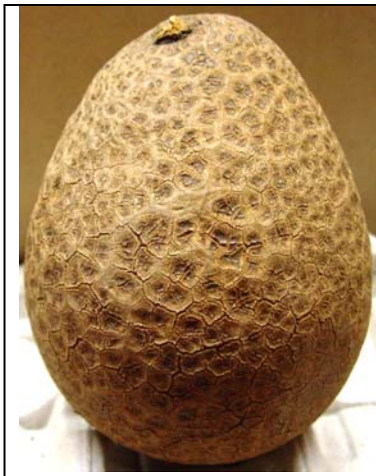
C.

Figure 11. Examples of fruit defects due to mechanical injury. A. Fruit squeezed between 2 branches during development. B. Constriction of fruit stem end during development. C. Scarring due to continual limb rubbing.

Fruit defects arising from fruit splitting

Although fruit splitting is uncommon in the Hass variety, it can be a problem in other varieties such as Bacon, Zutano and even Lamb Hass (from young trees). The cause is unknown. There are two distinct types of splitting. Stylar end breakdown or splitting occurs in many of the green skin varieties and normally starts at the stylar or blossom end of the fruit. These cracks (Fig. 13) can extend nearly to the stem end of the fruit. Side cracking or random splitting of the peel (usually horizontally) has been recently observed in Lamb Hass fruit coming from juvenile trees. It is not known if this is solely a juvenile characteristic of this variety or due to some environmental stress.

In conclusion, aberrant fruit can be caused by either genetic or environmental factors. The grower can do little about the occurrence of genetically induced abnormal fruit, but an alert grower can potentially modify their cultural practices to minimize the environmentally induced aberrant fruit.



A.

B.

C.

D.

E

Figure 12. Examples of fruit defects due to insect feeding. A. "Papacado", scarring due to avocado thrips feeding. B. Fruit damage most likely due to amorbia feeding. C. – D. Healed wounds on mature fruit. E.

Figure 13. Examples of side cracking or random splitting in 'Hass'.

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REFERENCES

Blumenfeld, A. and S. Gazit. 1974. Development of Seeded and Seedless Avocado Fruits. J. Amer. Soc. Hort. Sci. 99:442-448.
http://www.avocadosource.com/journals/ashs/ashs_1974_99_pg_442-448.pdf

Coit, J. Eliot. 1928. Pests and Diseases of the Avocado. California Avocado Association Yearbook 12: 18-21.
http://www.avocadosource.com/cas_yearbooks/cas_13_1928/cas_1928_pg_18-21.pdf

Hodgson, R. W. 1935. Avocado Fruit Abnormalities. California Avocado Association 1935 Yearbook 19: 108-109..
http://www.avocadosource.com/cas_yearbooks/cas_20_1935/cas_1935_pg_108-109.pdf

Horne, W. T. 1929. Carapace Spots. California Avocado Association 1929 Yearbook 14:129.
http://www.avocadosource.com/cas_yearbooks/cas_14_1929/cas_1929_pg_129.pdf

Horne, W. T. 1934. Avocado Diseases in California. University of California. College of Agriculture. Berkeley, CA. Bulletin 585. 72 pages.
http://www.avocadosource.com/papers/research_articles/hornewmt1934.pdf

Kadman, A., E. Tomer and M. Gottreich. 1973. Some Abnormalities Observed in Avocado Fruits and Flowers. California Avocado Society 1973 Yearbook 57: 115-117.
http://www.avocadosource.com/cas_yearbooks/cas_57_1973/cas_1973-74_pg_115-117.pdf

Lahav, E. And A. W. Whiley. 2002. Irrigation and Mineral Nutrition. Pgs 259 – 297. In: A. W. Whiley, B. Schaffer and B. N. Wolstenholme (eds.) The Avocado:Botany, Production and Uses. CAB International.

Platt, R. G. 1972. Some Troubles of Avocado Fruit. California Avocado Society 1972-73 Yearbook 56: 35-37.
http://www.avocadosource.com/cas_yearbooks/cas_56_1972/cas_1972_pg_035-037.pdf

Schroeder, C. A. 1953. Abnormal Fruit Types in the Avocado. California Avocado Society 1953-54 Yearbook. 38:121-124.

http://www.avocadosource.com/cas_yearbooks/cas_38_1953-54/cas_1953-54_pg_121-124.pdf

Tomer, E., S. Gazit and D. Eisentstein. 1980. Seedless Fruit in 'Fuerte' and 'Ettinger' Avocado. J. Amer. Soc. Hort. Sci. 105(3)341-346.
http://www.avocadosource.com/journals/ashs/ashs_1980_105_pg_341-346.pdf

Toerien, J. C. 1979. Seasonal Incidence of Ring-Neck on Avocados and Possible Causes. South African Avocado Growers' Association Research Report for 1979. 3:49-51.
http://www.avocadosource.com/Journals/SAAGA/SAAGA_1979/SAAGA_1979_PG_49-51.pdf

Zamet, D. N. 1996. On Avocado Fruit Size I. Parthenocarpic Fruit. California Avocado Society 1996 Yearbook. 80: 133-149.
http://www.avocadosource.com/cas_yearbooks/cas_80_1996/cas_1996_133.htm