that photosynthesis is reduced and the shading of surfaces causes foliar chlorosis or delayed fruit ripening.

Postharvest fruit washing can remove sooty mold, but contaminated fruit may be downgraded at the packinghouse. Manage sooty mold by controlling the insects that produce honeydew, as discussed in the chapter “Insects, Mites, and Snails.”

**FRUIT DISORDERS**

Weather-related causes of fruit damage include frost, rind disorders, sunburn, and wind. Also discussed here are split fruit related to cultural practices and water deficit, pesticide spray injury (phytotoxicity), rind injury (oleocellosis or oil spotting), genetic mutations (chimeras), and poorly understood maladies (peteca of lemons and puff and crease of oranges and mandarins). Some of these maladies can be confused with other causes of rind damage, as summarized in Table 3 in the chapter “Managing Pests in Citrus.”

Protecting trees from injury and providing proper cultural care as discussed in “Prevention and Management” at the beginning of this chapter help prevent many fruit disorders and the associated rots discussed above in “Fruit Diseases.” See the “Leaf and Twig Disorders” section later for more photographs and discussion of many of these maladies.

**Chimeras**

If genetic mutation occurs in a branch or twig and that tissue survives, it can produce new shoots (called a chimera or sport) with characteristics different from the rest of the tree. Mutations can affect the color of the rind or pulp or the shape of the fruit. Leaves on these twigs can have a different shape or size or variegated color. Mutation can cause the development of multiple buds, creating bunchy growth or “witches’ broom.” A chimera can produce an improved crop: some of today’s cultivars were propagated from chimeras. Usually sports are of inferior quality and should be avoided as propagation material. Prune sports that obstruct normal growth or interfere with harvest.

**Wind Injury**

In areas with persistent winds, fruit on the outside canopy can be scarred where twigs or thorns rub against the rind. Fruit can also drop from the tree. Strong, persistent wind causes water stress by dehydrating the leaves, causing leaf necrosis or twig dieback or stunting of the growth of young trees. Drying winds such as the Santa Anas cause bronzing, pitting, and curling of leaves, mostly on the outside of the canopy exposed to the wind. In certain coastal districts, chilling winds blowing from the ocean inhibit the normal growth of citrus.
Appropriate irrigation and windbreaks can help reduce wind damage. A natural windbreak can be a row of fast-growing tall trees. Individual shelters of burlap or wood frames may be suitable for young trees.

### Sunburn

Heat produced during direct exposure to intense sunlight can blemish fruit, cause chlorotic or necrotic leaf blotches, and produce bark cankers. On sunburned fruit, the side exposed to the sun develops brown, leathery areas. Some fruit become slightly lopsided. See the “Trunk Disorders” section for more discussion of sunburn and its prevention.

### Hail

Impact from hail tatters leaves and causes sunken scars on the upper and outer exposed surfaces of fruit and twigs. If hail impacts young fruit, scars can become large and distinctive as the rind enlarges.

### Frost and Freeze

Because it is a subtropical plant, citrus is particularly susceptible to cold damage (frost and freeze). Susceptibility to cold varies with the age and physiological state of the tree and with the cultivars of the rootstock and scion. For example, Eureka lemon and grapefruit are among the most cold-sensitive cultivars, whereas mandarin, Meyer lemon, and sweet orange are more cold hardy.

Immature or young shoots and fruit and young trees are the most susceptible to cold damage. Young trees can be killed. When trees are older, economic damage usually occurs only when fruit are injured. Cold ruptures oil cells in the fruit rind, resulting in oil leakage and damage to the rind surface, visible as watery, brownish specks or pits called ice marks. Fruit pulp underneath the ice marks ultimately dries, and the ice marks provide entry sites for decay organisms. Cold-damaged fruit may drop suddenly from the tree, or severe fruit damage can occur without fruit drop or obvious rind markings. This fruit is unmarketable, because the flesh is dehydrated. The damage may not be apparent until fruit is cut in cross section or processed at the packhouse.

Cold also can cause bark cankers and shoot dieback. Damaged leaves and twigs become water soaked, withered, and dark brown to black. Frost damage mainly appears on outer and upper shoot terminals and on the outside of fruit exposed to radiation frost.

Frost and freeze occur under different conditions but produce the same damage. See “Citrus Frost Protection” (in preparation) for more information.

Pale to brown scabby scars develop on the rind where fruit rubs against twigs or thorns.

Hail impact causes sunken scars on the exposed upper or outer surfaces of fruit and twigs.

When yellow to brown leathery areas occur on the unshaded surface of fruit in the south and west sides of the tree, the cause is probably sunburn. Nearby leaves may also have chlorotic or necrotic sunburned blotches.
This brown rind scarring sometimes develops on oranges after cold weather. Other times after cold damage no obvious external symptoms are visible on fruit even though flesh inside has been injured and the fruit is unmarketable.

This rind damage, called rind stipple or concentric rind stipple, sometimes develops on grapefruit after cold, wet weather. The brown discoloration occurs in numerous small pits.

Rind Stipple of Grapefruit

A unique pattern of rind discoloration develops on grapefruit during prolonged periods of cold, wet weather. The rind develops small, brownish pits (ice marks). The pits are often surrounded by concentric rings that are formed as water droplets dry. The pits may coalesce into larger, irregular lesions. If green fruit is injured, a green halo appears around pits and persists until the fruit turns yellow. This distinctive rind damage pattern has been reported only on grapefruit. The symptoms occur mostly on exposed fruit on the north side of the tree. Stippled fruit is downgraded at the packinghouse. No treatment is available.

Rind Disorder
(Mandarin Rind Disorder)

A rind disorder that develops on mandarins sometimes results in severe crop loss in the Sacramento and San Joaquin valleys. Brown, water-soaked blotches or dark, sunken areas develop on exposed surfaces of fruit in the outer canopy. Fungi develop in the discolored areas, and the flesh underneath softens and rots. Damage is most severe on Satsuma mandarins but occasionally occurs on other mandarin varieties such as Clementine.

Mandarin rind disorder occurs during high rainfall in the fall. Once fruit begin to develop mature color, rind injury becomes apparent within days after rain. The disorder is a physiological problem that develops during adverse environmental conditions when the rind becomes water soaked and the oil glands rupture. The injured rind is then colonized by various secondary decay fungi. Treatments include one or two foliar applications of oil or antitranspirants that repel water, applied before forecasted rain or around fruit color break.

Peteca of Lemon

Coastal lemons sometimes develop round depressions in the rind that become discolored or brownish. Called peteca, this necrosis and collapse of albedo cells becomes obvious after harvest. Less-obvious damage is sometimes visible before harvest as slightly brown, sunken spots on the skin. The cause is unknown.

Once fruit develop mature color, dark, sunken blotches can develop on mandarins within a few days after rainy weather. This rind disorder most often occurs on Satsuma mandarins.
The innermost spongy white layer of the rind (albedo) sometimes separates from the outer surface of the fruit segments. This internal damage is visible externally as an uneven appearance of the rind surface. Some portions of the rind surface appear inflated (puffy) and other areas are indented (creased), hence the name “puff and crease.” Navel and Valencia oranges and Satsuma mandarins are susceptible to this tissue separation.

Symptoms become increasingly prevalent as fruit mature. There may be physiological differences between damage development on oranges versus mandarins. Puff is sometimes considered a separate malady from crease, but their overall damage appearance is similar. The cause of rind separation from flesh and how to prevent it are not well understood. The application of plant growth regulators and various cultural practices and environmental conditions (irrigation, nutritional status, temperature, and fruit load) may influence the extent to which puff and crease occurs. Consult “Citrus Physiology and Phenology” (in preparation) for more discussion.

Puff and Crease

Lemons growing near the coast sometimes develop depressions in the rind that become discolored or brownish. This disorder is called peteca.

Oleocellosis (Oil Spotting)

A phytotoxic reaction occurs from peel oil when glandular cells in the rind are injured. Oleocellosis (also called autophytotoxicity, autotoxicity, or oil spotting) occurs on rinds after abrasion, rough handling, or thorn punctures. The rind of oranges and lemons is especially susceptible to this disorder. Wet conditions from high rainfall or excessive irrigation often result in a more turgid rind that can worsen the condition if harvest immediately follows these conditions. Occasionally, when turgid fruit are exposed suddenly to low temperatures, peel oil may be released, causing oleocellosis.

Split Fruit

After tree stress, rinds often split at the bottom of fruit. Causes of tree stress include unseasonably high temperatures or other extreme weather, inadequate irrigation, and potassium deficiency. Decay fungi usually colonize wounded fruit, resulting in secondary diseases such as Alternaria rot and blue and green mold. Even when only a few fruit are affected on the tree, pathogen spores developing in split fruit can disperse and heavily contaminate healthy fruit surfaces. After harvest, this pathogen contamination can cause postharvest fruit rot.

This uneven appearance and cracking on the outer surface of Valencia orange rinds is called crease. The top of the right fruit also has a raised or inflated ridge. Internally, the rind has separated from flesh. Other names for this puzzling malady include crease, crease and split, puff, or puff and crease.

Rind split, usually at the bottom of fruit, can occur after tree stress. Extreme weather and poor irrigation are common causes of split fruit.
Spray Injury (Phytotoxicity)

Pesticide sprays, such as fungicides, growth regulators, herbicides, and oils, can injure citrus trees, causing phytotoxicity. Most agricultural chemicals can cause damage if used incorrectly or applied during adverse environmental conditions. See "Leaf and Twig Disorders" for more discussion and photographs of spray injury.

LEAF AND TWIG DISEASES

Several pathogens and abiotic disorders cause leaves and twigs to wilt, die back, distort, or become discolored, often without affecting other parts of the tree. Most leaf and twig diseases do not cause serious long-term losses in citrus. However, pathogens and other pests affecting roots, trunks, and overall tree growth often cause symptoms on leaves and twigs as well. Be sure to diagnose the cause of leaf and twig symptoms correctly by inspecting the whole tree and comparing your findings with the appropriate sections of this book. For example, anthracnose and Botrytis rot are pictured below but are discussed mainly in the "Fruit Diseases" section. Other causes of damage are presented under "Leaf and Twig Disorders," "Exotic Diseases," and "Diseases Affecting Growth Habit and Yield."

To minimize leaf and twig diseases, provide good cultural care to reduce tree stress. Prune out dead and diseased limbs and twigs in spring after the rainy period to reduce pathogen spore production and disease. Proper fertilization timing can reduce disease, so schedule fertilization and pruning during spring or early summer and avoid these activities later in the season. This timing minimizes excessive new growth during fall (this stage is particularly susceptible to bacterial infection and freeze damage). Cold-damaged tissue then becomes susceptible to anthracnose and other diseases. Windbreaks can reduce the incidence of wind-associated bacterial blast. Use bushy cultivars with relatively few thorns to help avoid injuries that become sites of pathogen infection. For more recommendations including fungicides, consult the online UC IPM Pest Management Guidelines: Citrus.

Bacterial Blast
(Citrus Blast, or Black Pit)

_Pseudomonas syringae_

Bacterial blast, also called citrus blast, kills leaves and twigs. When fruit are damaged, the disease is called black pit. Bacterial blast occurs mainly in the Sacramento Valley, where wet, cool, windy conditions during winter and spring favor development and spread of the blast bacterium. Leaves and twigs of oranges and grapefruit and the fruit of lemons are the most susceptible to infection.

Infections caused by _Pseudomonas syringae_ usually start as small water-soaked or black lesions in the leaf petiole and progress into the leaf axil. Once the petiole is girdled, leaves wither, curl, and eventually drop. Entire twigs may die back. Diseased areas on twigs are reddish brown and can become scabby or callused. Dieback scattered throughout the canopy creates the "blast" appearance for which the disease is named. Bacterial blast damage may be confused with symptoms from Dothiorella