Frost Damage to Walnut Kernels

low temperatures during harvest season may cause injury to kernels resulting in chemical changes that produce rancidity

L. L. Claypool and Paul Esau

Late harvested walnuts in some areas of northern California—though not a common occurrence—have suffered considerable freezing injury to walnut kernels.

Recent heavy plantings of walnuts have been made in areas subject to frost at harvest time. As a result, serious harvest problems may be encountered in seasons when nuts mature late or when freezing temperatures occur in late October or early November. Since 1940, freezing weather has occurred in Lake County—for example—at harvest time in 1946, 1948, 1949, 1953, 1954, and 1955. In 1946 and 1948, weather conditions were particularly conducive to frost damage. In 1946, temperatures of 25°F or below were recorded on several days in late October and early November. Subfreezing temperatures—below 28°F—were recorded on several days in late October and early November. Subfreezing temperatures—below 28°F—were recorded on several days in late October and early November.

Frost Conditions

For acute danger of damage by frost, several conditions must coincide: 1, temperatures below 28°F; 2, conditions favoring radiation, such as a clear night and a low dew point; 3, at least partial defoliation of the tree; and 4, high moisture content of the nuts.

Conditions favoring radiation and defoliation of the trees facilitate freezing, but temperatures below 28°F and high moisture content of the nuts may be—in themselves—sufficient for freezing to occur. When freezing temperatures occur during harvest time, the moisture content of the nuts is likely to be high enough to result in kernel injury.

In slow freezing it is generally assumed that damage results from rupture of the cell walls by ice crystals. All later signs of damage are the result of this injury to the cells. Damage shows itself in several ways, depending on the condition of the kernel. The earliest sign of frost damage, regardless of kernel condition, is a darkening of the skin—the pellicle—of the meat. When fully mature frozen nuts are placed in storage in the 32°F-68°F range and exposed to spontaneous loss of moisture, no visible change in the texture and color of the meat occurs. However, exposure of mature frozen nuts to high temperature soon after freezing—as maintained in dryers—produces an oily appearance of the meat. Immature kernels after freezing show signs of internal collapse and become rubbery in texture. These outward changes are followed by odor and taste changes. The more rapid flavor changes of frozen kernels than of those not frozen are the result of chemical changes that occur in the oil. These changes may be oxidative or enzymatic, or both, and are known collectively as rancidity. A normal walnut kernel contains two protective devices that retard rancidity: 1, the oxidative changes are retarded by an efficient antioxidant; and 2, an effective barrier prevents the enzymes from attacking the oil. In a frozen kernel both systems are disturbed and these protective devices are removed. This allows rancidity to develop quite rapidly, depending somewhat on the temperature at which the nuts are held.

Influence of Moisture Content

Under controlled laboratory conditions, the freezing point of walnuts was related to moisture content. These results were an aid to interpreting data collected in the field at Davis on nights sufficiently cold to freeze walnuts.

During harvest the moisture content of kernels may range from 20% to above 40%, depending upon the degree of separation of the nuts from the hulls and release of the kernels from the hulls.

Freezing point and undercooling of walnut kernels in relation to moisture content.

Freezing of walnut kernels under laboratory conditions. Note the abrupt rise in temperature to the freezing point when ice crystals begin to form.
Advantages

There are numerous advantages of the hot-water treatment of gladiolus corms. Bigger corms and a much higher yield of cormels are produced and most corms produced the first year are of blooming size.

Clean corms yield a higher flower cut and flowers are produced from smaller size corms when they are disease free. Furthermore, the plant stock may be used for a number of seasons.

The hot-water treatment enables the growing of several varieties which demand a high price, but which have been unprofitable since planting stocks have become infested with disease. Also, treatment preserves rare varieties or new crosses and makes possible a more rapid increase.

Influence of the Hull

When an early frost occurs, a substantial part of the crop may be on the trees with hulls intact to a varying extent. The moisture content of an intact hull or one just beginning to split is about 86%. This high moisture content favors freezing of the nut. Experimental freezing of intact hulls shows that the freezing point is the same as that for kernels of high moisture content, that is, 28°F plus or minus 1°F. The hull also may or may not pass through the undercooling stage before freezing, but whatever happens to the hull will affect the nut. If the temperature of the hull after undercooling rises above the freezing point, the nut will not freeze. But the kernel will freeze in the same instant if the hull freezes. Attempts to induce independent freezing of the hull and of the nut by creating a moisture-proof barrier between the hull and the shell failed.

The condition of the hull may serve as an indicator as to whether or not frost damage has occurred. A frozen hull breaks down quite rapidly. The hull of experimentally frozen walnuts became dark and mushy in 24 hours, staining the shell.

Varying Conditions

Response to any particular treatment does not always occur. Variations in soil type, growing conditions, species of tree, and perhaps rootstock are influential in the amount of response to various treatments. At the present time it appears that, in California, the distribution of copper-deficient trees—of all species—is restricted to comparatively quite small areas in different districts.