Fruit Culture in Alabama
Winter Chilling Requirements

► Learn the basic chilling requirements of fruit types selected for planting. Check regional maps for Alabama's fall and winter temperatures and the chilling requirements for both small fruit and tree fruit crops.

The amount of cold needed by a plant to resume normal spring growth following the winter period is commonly referred to as its *chilling requirement*. Plant species as well as horticultural varieties vary widely in their winter cold requirement. Fruit producers should consider the chilling requirements of fruit types they select for planting.

What Happens During Winter Chilling

During the fall and winter, deciduous fruit plants enter a dormant period that is generally referred to as the plants' *rest period*. Plants enter the rest period in the fall as air temperatures begin to drop below 50 degrees F, leaf fall occurs, daylight decreases, and visible growth ceases.

Plants enter the dormant, or rest, period as the level of growth-regulating chemicals in buds changes. In other words, as the growth-regulating inhibitors increase and the growth-regulating promoters decrease, plants begin their dormant period. As the chilling requirement of a plant is being satisfied by cold temperatures, the level of promoters begins increasing while the level of inhibitors decreases. The higher levels of promoters in the buds allow normal resumption of growth and flowering in the spring as the chilling requirement is met.

Dormancy is reached in stages (table 1). The initial stage of dormancy is called paradormancy. This stage has also been called ectodormancy. Paradormancy involves the influence that the apical meristem and leaves have over the later buds. In the fall when temperatures become cold and day length is shorter, leaves drop from trees and buds enter ectodormancy or the rest period. Buds are in a true dormancy period that is beyond the control of the apical meristem and will not develop as a result of defoliation. Endodormancy is also divided into two sub stages. These are s-endodormancy and d-endodormancy. Rest-breaking chemicals are often applied several weeks before anticipated bud break if insufficient chilling is expected. During s-endodormancy, these chemicals can affect bud break in the spring. Conversely, during d-endodormancy, rest-breaking chemicals have no effect on bud break. Finally, ecodormancy is a stage of dormancy controlled by environmental factors such as cold weather. Buds that have received sufficient chilling will not begin to develop until temperatures become warm.

Table 1. Stages in the Development of Bud Dormancy

Stage of Dormancy Development	Description
Paradormancy	Initial stage. Bud development is inhibited due to the influence of the apex or leaves.
Endodormancy	True rest period. Bud development cannot be induced by defoliation or pruning.
s-Endodormancy	Period when rest-breaking chemicals are effective.
d-Endodormancy	Rest-breaking chemicals are not effective.
Ecodormancy	Bud development is inhibited by unfavorable conditions

Measuring Winter Chilling

The type of cool temperatures needed to satisfy the chill requirement of fruit plants, especially tree fruits, has been carefully studied. Plants accumulate chill when exposed to temperatures of approximately 29 to 64 degrees F; however, the most efficient temperatures at which a plant receives chilling is 43 degrees F. And daily temperatures of 70 degrees F and higher for four or more hours can actually negate chilling that was received by the plant during the previous 24 to 36 hours.

Studies of chilling temperatures have resulted in the development of a number of models that are designed to better measure the accumulation of chilling and determine when rest is satisfied. These models were developed as improvements over the old method of measuring chilling accumulation by monitoring daily temperatures of 45 degrees F and lower beginning October 1 each year.

Among the models tested across Alabama, the Modified 45 has provided the best prediction of when rest is satisfied by cold temperatures. Compared to other models tested in Alabama, this model uses a more sophisticated method of determining when rest actually begins in the fall (rather than arbitrarily using October 1 as the starting date) and measures hours at or below 45 degrees F. It does not take into account the negative effect high temperatures may have on chilling accumulation, and it does count chilling hours below 32 degrees F. After five years of study, however, the Modified 45 has proven superior to the Utah, the Florida, and the Old 45 methods of measuring chilling under Alabama conditions.

Another chill model that was developed for climates that experience periodic warming trends during winter, such as in Alabama, is called the Dynamic model. It measures chill portions rather than chill hours. Studies leading to the development of this model found that chill is accumulated most efficiently at 43 degrees F. As temperatures move above or below this ideal temperature, chill is accumulated less efficiently. In the future, this model will likely be used in the southeastern United States in place of the Modified or Old 45 models as it is the most accurate in predicting chill accumulation during cool weather as well as loss of chill experienced during warming trends.

Remote weather stations across Alabama collect weather and temperature information to help fruit producers determine when chilling requirements have been met. The levels at which chilling hours have accumulated across the state during the most recent ten-year cycle are illustrated in figure 1.

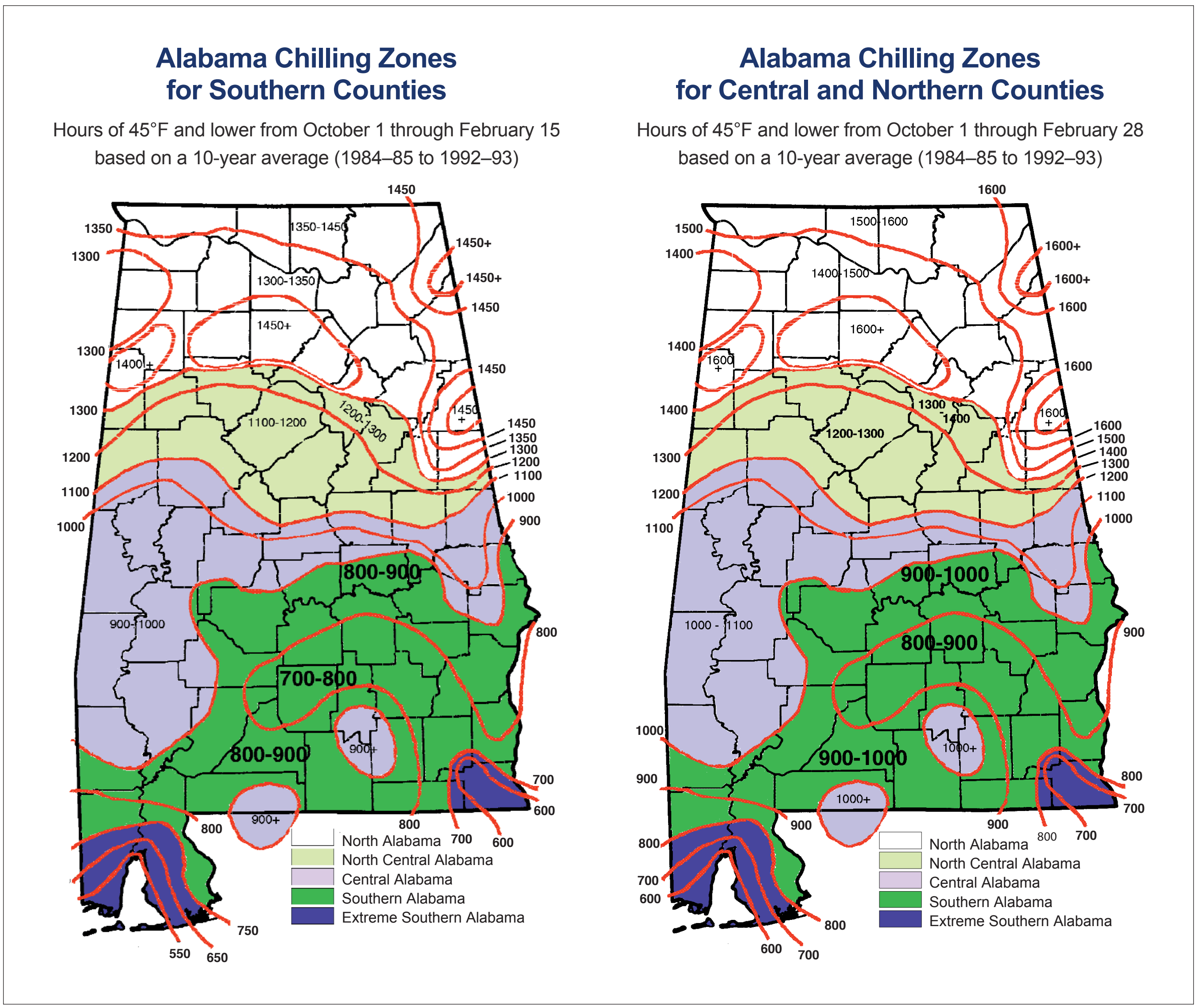

Figure 1. Fruit-growing regions of Alabama based on fall and winter temperatures

Winter Chilling Requirements in Alabama

Chilling needs vary with fruit types, but estimates of chilling requirements for the most commonly grown fruit types are listed in table 2. The cold or chilling requirement of peach and nectarine trees, and sometimes other plants, is generally listed in the catalogs of most nurseries that sell these plants. For example, Sentinel peach is listed as having an 850-hour chilling requirement. This means that to successfully grow this variety in a particular area, it should receive an average of at least 850 hours of temperatures at or below 45 degrees F during the fall and winter period. Most varieties have the same chilling requirement for leaf and fruit buds.

Table 2. Chilling Requirements for Fruit Types

Fruit Type	Chilling Requirement (hours at or below 45°F)
Apple, standard	800 to 1,100
Pear, European hybrids	800 to 1,100
Pear, hard	400 to 900
Asian pear	600 to 900
Peach and nectarine	400 to 1,050
Plum, Japanese	400 to 750
Cherry	1,000+
Muscadine, grape	200 to 600
Blackberry	50 to 800
Blueberry, highbush	900 to 1,000
Blueberry, southern highbush	150 to 500
Blueberry, rabbiteye	400 to 700

Growing Degree Hour Requirements

Once the chilling requirement of a plant is satisfied, the buds begin to slowly break dormancy as temperatures climb above 40 degrees F. Each type of fruit plant and variety has a particular heat unit or growing degree hour (GDH) requirement to reach a given level of bud, flower, and fruit development.

Growing degree hours begin accumulating as the air temperature rises to 41 degrees F and higher. They are measured in the following way. A base temperature of 40 degrees F is subtracted from either the temperature for that hour or 77 degrees F, whichever is lower. (If the air temperature does not rise above 40 degrees F, no GDHs accumulate.) Here's an example: if the air temperature at 6 a.m. is 35 degrees F, no GDHs are accumulated. When the temperature at noon rises to 65 degrees F, 25 GDHs are accumulated (65 – 40 = 25). And when the temperature at 4 p.m. reaches 80 degrees F, 37 GDHs are accumulated (77 – 40 = 37). Temperatures above 77 degrees F are treated as though they were 77 degrees F because no additional heat benefit is derived from higher temperatures (based on research test models). A warm day in spring can result in 650 to 700 GDHs accumulating in 24 hours.

The GDHs for each hour are totaled over time and can be used to predict the stage of development of the plant. For example, peaches usually require 10,000 to 13,000 GDHs to reach 50 percent bloom stage after rest is satisfied. The combination of chilling requirement and GDHs determines whether a particular type or variety of fruit normally flowers early, midseason, or late in the late winter/spring period. For example, muscadine, grape, fig, and certain Florida peach varieties all have low chilling requirements (200 to 400 hours), which implies that they would usually have their chilling requirements satisfied early in the winter. On the surface, one would conclude that this should lead to very early flowering and possible freeze damage. The early flowering, however, would only be a problem for the Florida peach varieties because they only have a moderate GDH requirement. On the other hand, muscadines, grapes, and figs all have very high GDH requirements, which means they normally flower late in the spring (in spite of the low chilling requirement). Apples tend to flower late compared to other tree fruits because standard varieties have high chilling requirements and high GDH requirements. Thus, an ideal fruit variety is one that possesses a chilling hour requirement that is satisfactory for the area where it is grown (the higher the better) and a high to very high GDH requirement. This helps ensure later flowering and more consistent cropping. Many varieties of fruit being grown, however, simply do not have the ideal chilling/GDH requirement combination.

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Edited by **Edgar Vinson**, *Extension Specialist*, Assistant Research Professor, Commercial Horticulture. Written by **Arlie Powell**, former *Extension Horticulturist*, **William Dozier**, Professor, Horticulture, **David Williams**, former *Extension Horticulturist*, and **David Himelrick,** former *Extension Horticulturist*, all with Auburn University.

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