Production of temperate-zone fruits in the tropics and subtropics may seem fanciful to the uninitiated, but it is a practice that has existed in localized regions for generations. Seedling peaches are grown in Venezuela (7), northern Thailand (11), and southern Mexico (5). No one knows precisely when these species were introduced, but local selection has produced cultivars adapted to areas with little or no chilling temperatures. Rest either does not occur (5) or is sufficiently shallow to be broken by stress induced by defoliation or drought.

In other areas, whole new industries have developed based on newly introduced species. In Venezuela, for instance, production of table grapes increased from negligible quantities in 1964 to 6000 t in 1983 (1), making the nation self-sufficient in this commodity. Commercial cultivars of temperate-zone fruits are well-established in subtropical areas, where winter temperatures allow partial breaking of the rest period. In areas of northern Mexico, southern Africa, and Israel, for example, chemical treatments are regularly applied to supplement the effects of limited chilling. Because temperature declines with increasing elevation, many microclimates exist in the tropics and subtropics where temperate-zone fruits are not currently grown, but could be (6).

Breeding programs have provided new cultivars selected for their short chilling requirements and tolerance to high temperature. One of the most successful cultivars is ‘Anna’ apple, developed by A. Stein in Israel. This is now extensively grown in areas with limited chilling. R. Sharpe (Univ. of Florida) established a breeding program and selected numerous peach and nectarine cultivars suitable for northern Florida (8). These cultivars, together with those developed by his successor, W. Sherman (9, 10), are widely planted today in the tropics and subtropics. Brazil also supports an active fruit breeding program (2); without these cultivars the growth of the Brazilian peach and apple industries would have been delayed.

A small group of interested persons met at the ISHS Congress in Hamburg, F.R.G. in 1982 to discuss the need for a working group to deal with the problems specific to temperate-zone fruit production in the tropics and subtropics. Subsequently, a group was organized under the ISHS Commission for Tropical and Subtropical Horticulture. The first workshop was held in Jan. 1984 in Addis Ababa, Ethiopia, in conjunction with the 10th African Horticultural Congress, and the second was cosponsored by the ASHS Tropical Region, the Fundacion Servicio para el Agricultor (FUSAGRI), and several other Venezuelan organizations in Cagua, Venezuela, in Dec. 1985. Papers presented at Addis Ababa were published in Acta Horticulturae, vol. 158, those presented at Cagua will be published in Acta Horticulturae, vol. 199.

The current symposium is our first. Future plans call for symposia and/or workshops at quadrennial ISHS Congresses, with intervening workshops being scheduled at 2-year intervals. The next workshop is planned for Thailand in Dec. 1988.

The primary purpose of the working group is to exchange information concerning cultivars, rootstocks, and cultural practices through newsletters, workshops, and symposia (3, 4). Training schools in developing countries for persons with little or no knowledge of temperate fruits, and cooperative research, are also possibilities. The objective of this symposium is to provide an overview of a number of aspects of breeding, producing, and marketing temper-
ate-zone fruits in the tropics and subtropics. For this purpose, we have scheduled five invited papers that discuss methods of determining chill units at low latitudes, where meteorological conditions during the dormant period can differ markedly from those in the temperate zone; breeding of apples and peaches for warm climates; cultural methods for preventing rest from developing, thereby permitting two or more crops to be harvested per year; and the breaking of rest by chemical treatment. In the final paper, some economic considerations will be reviewed; this aspect is crucial, for production obviously cannot succeed unless it is based on economic realities.

Literature Cited


Estimating Chill Units at Low Latitudes

José Ignacio del Real Laborde
Instituto Nacional de Investigaciones Forestales y Agropecuarias
CIANOC, CAEVAG, Campo Frutícola Experimental, Apdo. Postal #52, Canatlán, Dgo, 34400, México

Deciduous fruit species are generally of temperate-zone origin. When they are grown under subtropical conditions, climatic requirements may not be fulfilled and their growth and yield reduced (10, 12, 13, 15, 30, 31, 35, 59, 62, 63). Cultural practices designed to improve plant growth and yields are necessary in areas with mild winters (23, 24, 29, 33, 46, 53, 57). Proper cultivar selection is needed to obtain genotypes most compatible with the climate (30, 31). Even plants that appear to be well-acclimated may require cultural or chemical means to break rest in warm winters. Rest-breaking practices, in order to be fully effective, must be performed at the optimal time, which can have an action window of only a few days. Therefore, the need for reliable methods to evaluate tree response to environmental conditions during rest is an important concern of fruit growers in low latitudes.

Low latitude characteristics

Climatic conditions. Deciduous fruit-growing areas in Mexico are located as far south as Puebla at lat.19°N; however, the main growing areas are located around lat.25°N. They are typically located at high altitudes, ≥1800 m, although grapes, apples, and peaches are grown at sea level in the Hermosillo area (22). The following data from the Artega apple-growing region located in the state of Coahuila illustrate temperature conditions present during winter months.

Wide fluctuations in temperature occur daily. The average mean air temperature is 10°C during winter months, but the daily temperature fluctuations range from 17°C to 28°C (Figs. 1 and 2). When plants are grown under these conditions, they are subjected to tremendous changes in temperature during the day, which reduces their capacity to complete rest and have normal growth and development during the growing season. Temperature varies from year to year and trees may have different growth responses in the spring following winters with similar average temperatures (17). As a result, apples have an extended bloom that can last up to 5 weeks and, if not treated with rest-breaking agents, show symptoms of delayed foliation (30, 31). From 1972 to 1984, leaf-bud opening averaged 61% when evaluated 10 days after full bloom, but was as low as 25%. Retarded leaf development reduces yield considerably, with the result that average apple production in Mexico is 8.5 t·ha⁻¹. However, yield can reach 80 t·ha⁻¹ under optimal conditions. For this reason, it is essential to have a reliable method to forecast tree rest development in relation to temperature in mild climates.

Chilling accumulation systems

Chilling concept. Although winter temperature has always been considered an important factor in fruit production, it was not until 1893 that Jost (46) initiated a study of low temperature responses. Several studies and reviews have been devoted to understanding rest (36, 47–51, 56). In 1932, Hutchins proposed 7°C as the threshold temperature for chilling (58). In 1934, Weldon observed that when average temperatures for December and January were > 9.4°C, trees suffered delayed foliation (61). Based on these and other observations, Weibner, in 1950 (58, 59), correlated the performance of peach cultivars to hours accumulated at temperatures < 7°C, which he designated as chill hours (CH). This concept has been in use ever since. In 1954 (60), the effect of high temperatures began to be considered not only as unfavorable for the development of rest but also as negating previous chilling temperatures (11).

Chilling hour systems. Weibner proposed a set of CH values based on the average temperatures of the winter months and concluded that mean temperature values for December and January gave an acceptable relationship to tree response (61, 63). At the same time, in Brazil, Da Mota (16) developed an equation to calculate CH under Rio Grande do Sul conditions in an attempt to evaluate chilling in mild winters. Chilling requirements for different species were calculated using these and other methods (4, 54).

It became common to calculate CH from thermograph records, summing hours below the threshold temperature. In 1969, Muñoz Santa Maria (38) reviewed some CH systems and concluded that the values obtained by Da Mota’s equation were most suitable for central Mexico. In 1972, González-Cepeda (33) introduced the concept of adjusted chilling hours, in which the final value for the day was calculated by the formula: hr below 7°C – 2 (hr above 18°C). This calculation, when used under northern Mexico conditions from 1 Nov. to 28 Feb, proved more accurate than the CH calculations from average temperature data or daily thermograms.