Programming Fruit Firmness

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Introduction

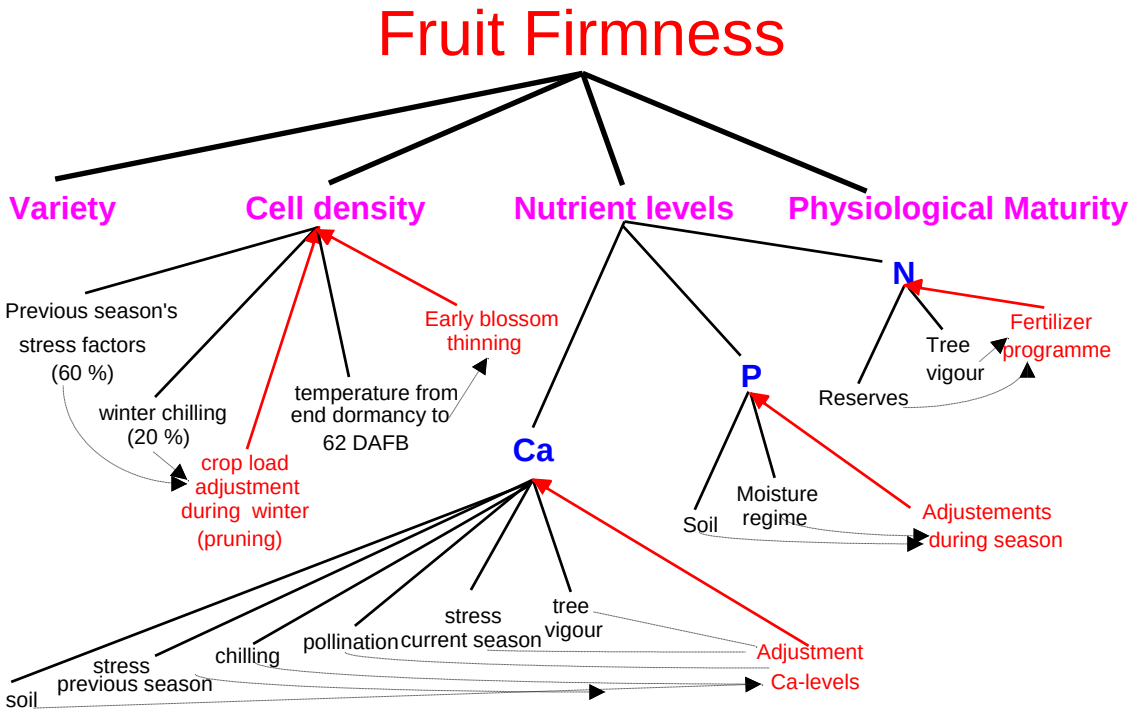
Fruit firmness is one of the most important characteristics of apple quality. Unfortunately, however, it is also a characteristic that tends to be influenced greatly by many pre-harvest and post-harvest factors (See Technical background). Obtaining and maintaining apple fruit firmness from the orchard through to the consumer, therefore, tends to be one of the major issues facing apple producers.

Fruit firmness at harvest -at the multiples or at the consumer- is the result of a long process and not just something that happens during picking or storage. To obtain an acceptable firmness, "programming" has to start one year prior to harvest.

Technical background

Apple texture (firmness) is related to wall structure and the relative areas of cell-to-cell contact. The size of the cells have an influence on firmness, as well. Normal or large fruit with a low cell number often show low firmness or an accelerated loss of firmness.

At comparable fruit size often show up to 1.5 kg (3.3 lb.) difference in firmness, due to variety (even mutation), cell density, nutrient levels, and physiological maturity.



The chart above lists all factors that influence final firmness at harvest and that the producer can use to programme the final firmness.

Variety

Most apple and pear quality characteristics, including fruit firmness, are genetically controlled and thus vary with cultivar (e.g. Gala is much firmer than Elstar). The strain (mutation) can also influence fruit firmness both at and after harvest.

Cell density

Cell density depends on:

1. previous season's **stress factors** - influenced by climate, soil moisture, crop load, red spider and other pest and diseases that affect leaf efficiency.
2. **winter chilling** - determined by climate, reserve status of the tree and leaf drop.
3. **crop load adjustment** during winter - This will assist cell division in spring. It entails detailed pruning. Fruit bud numbers are adjusted to a predetermined production and fruit size. It requires the production potential per block per variety, bud weights, fruit bud analysis, and pruning to the required number of fruit buds.
4. **early thinning** (chemical or manual) - i.e. crop adjustment prior to T-stage (~ 40 days after full bloom). This will assist to increase the number of cells in the fruit. At a later stage cell division has stopped and cell numbers cannot be increased. Cells only enlarge.
5. **temperatures from end dormancy until 6 weeks after full bloom** - at very high average temperatures fruit develop a loose cell structure. Low temperatures during the first 6 weeks after blossoming are detrimental to cell division and cell growth and therefore slow down the growth rate, while higher temperatures speed up the process.

Nutrient levels

Calcium

Apples and pears with a high calcium level remain firmer (0.2 - 0.5 kg) during storage This is due to two factors:

1. Calcium preserves structural integrity of the cell wall and maintains cell cohesiveness. Softening (loss of firmness) is characterised by changes in composition and structure in cortical cell walls. These changes occur predominantly in the middle lamella region and result in a loss of cell cohesive strength and textural quality. Effect of calcium on the integrity of the cell walls: calcium inhibits hydrolyses (breakdown) of pectin by the enzyme polygalacturonae (PG). The middle lamella, a clearly distinguishable section of the cell wall, which separates adjacent cells and serves as a bonding agent for cells, is rich in pectin. When the middle lamella is broken down the cells separate and firmness falls. Fruit becomes soft and eventually becomes mealy.
2. Calcium slows down ethylene formation and respiration. Therefore ripening is slowed down.

Phosphor

The higher the P-levels, the better firmness is maintained. P-level at harvest should be at least above 9 mg/100g F.W.

Nitrogen

High N- levels in the fruit result in a low pulp density (larger cells) and therefore loss of firmness.

Nitrogen can have an effect of up to 1 kg (2 lb.)

Physiological Maturity

From pre-climacterium (Release Date - RD) firmness drops at a constant rate. The rate depends on the calcium, phosphor and nitrogen level in the fruit. At the end of the fruit's life firmness increases due to mealiness. In that case the cells have separated and are compacted by the penetrometer before the plunger penetrates, simulating a firmer fruit.

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