Complementing these tree-scale models, a regional decision-support tool was developed for the U.S. Midwest and Southeast to anticipate major yield reductions from false springs, using accumulated growing degree days (GDD7.2) and minimum temperatures during freeze events. For each region, an “envelope” curve relating GDD to critical minimum temperature was derived from historical low-yield years; stations falling below this envelope in a given season were classified at risk of major peach yield loss. This approach illustrates how simple temperature-based indicators can be operationalized for risk forecasting at regional scale.

8.3 Validation of predicted yield and quality against observations

Validation of the Brazilian machine learning models used independent data from the same orchards, confirming that Random Forest calibrated with climatic, soil, and foliar variables could reproduce observed yield variation with high accuracy, while simpler linear models underperformed, especially when only a subset of predictors was used. Feature-importance analysis aligned with agronomic expectations-emphasizing chilling hours and mean temperature-supporting both statistical and physiological credibility of the fitted relationships (Moura-Bueno et al., 2026). At the quality level, comparisons among subtropical cultivars showed that modeled GDD-based development patterns were consistent with observed differences in fruit size and mass between low- and high-GDD genotypes, strengthening the case for GDD as a robust explanatory variable for quality-related traits .

For the regional false-spring tool, validation against historical high-yield years demonstrated that the GDD-minimum-temperature envelope correctly identified non-damaging seasons in all sampled years for the Midwest and in 75% of high-yield years for the Southeast, indicating strong but regionally variable skill (Chun and Changnon, 2018). Application to the 2017 false spring showed that the tool successfully anticipated widespread yield reductions in the Southeast while correctly indicating lower risk in much of the Midwest, when observed production data were later examined. Together, these evaluations show that temperature-driven models can achieve useful predictive power for both yield level and catastrophic loss when carefully calibrated to local climate and production systems.

9 Development of Climate-Resilient Peach Production Strategies

Climate-resilient orchard management increasingly focuses on mitigating insufficient winter chill and buffering trees against temperature extremes. In the southeastern United States, anthropogenic warming has already reduced winter chill, increased the probability of low-chill winters, and raised the risk of insufficient chill for moderate- and high-chill cultivars, prompting consideration of adaptive practices such as overhead irrigation for evaporative cooling, vigor control to lower chill needs, and site selection in cooler microclimates. In warm-winter regions like Israel, additional physical strategies-including shading, branch bending, and sprinkling to reduce daytime temperature-are proposed to compensate partially for chill deficits and reduce abnormal bud development and low fruit set under heat spells.

Postharvest temperature management is another critical component of climate-resilient peach systems. Poorly controlled cold chains with repeated temperature spikes to 15°C-20 °C sharply increase ethylene production, accelerate softening, and reduce phenolics, flavonoids, and antioxidant enzyme activities, whereas limiting fluctuations to around 10 °C has little impact on quality, delineating operational thresholds for transport and storage. Reviews of cold-stress physiology emphasize that careful management of storage and transport temperatures, combined with early, preferably non-destructive monitoring tools for chilling injury, is essential to safeguard fruit quality as supply chains lengthen and temperature variability increases.

Climate-resilient production depends strongly on matching cultivar chilling and heat requirements to warming agroclimates. Multi-site analyses across Tunisia and Europe show wide genotypic variation in peach chilling (≈20-63 Chill Portions) and heat requirements (≈4381-6556 GDH), with warm mean temperatures during the chilling period emerging as key drivers of flowering, providing a quantitative basis for selecting cultivars adapted to warm regions. Under mild Moroccan conditions, grouping cultivars by chill/heat needs and flowering time identified low- to medium-chill types as more suitable under climate change, while cultivars like ‘Summer Lady’ showed lower sensitivity to bud and fruit drop during warm autumns and chill deficits, making them strategic genetic resources (Borgini et al., 2024).