Abstract

Tree grafting represents one of humanity's oldest and most sophisticated agricultural techniques, with documented use spanning over 4,000 years across diverse civilizations. This comprehensive transdisciplinary review synthesizes biological mechanisms, historical development, technical methodologies, agricultural applications, economic impacts, and cultural significance of tree grafting, while presenting a computational toolkit for compatibility prediction, success analysis, and decision support. Building on foundational horticultural research [**?**, **?**] and recent advances in plant biology [**?**, **?**], our work makes several significant contributions: a unified framework for understanding graft compatibility based on phylogenetic relationships, cambium characteristics, and environmental factors; comprehensive analysis of major grafting techniques (whip & tongue, cleft, bark, bud, approach, bridge, inarching) with success rate predictions; biological simulation models of cambium integration, callus formation, and vascular connection; species compatibility database with rootstock-scion pair recommendations; seasonal planning