At the production level, inflorescence number is usually closely associated with plant vigor, nutrient supply, growth habit, and pruning or branch-retention practices, whereas the number of flowers within each inflorescence determines the upper limit of its fruiting potential. Different inflorescences on the same plant do not contribute equally to yield. Continuous inflorescence studies in greenhouse cherry tomato have found that middle-position inflorescences often outperform some upper or lower inflorescences in terms of flower number, production efficiency, and related biochemical performance, indicating that inflorescence position, local light and thermal environment, and assimilate supply jointly affect the efficiency with which flower number is converted into fruit number (Jerca et al., 2024). Therefore, in protected cultivation, maintaining high differentiation quality of all inflorescences, especially effective middle and upper inflorescences-through rational dense planting, pruning, nutritional regulation, and inflorescence load management is a key step for improving yield stability (Jerca et al., 2024).

From the perspectives of developmental biology and genetic regulation, inflorescence structure itself determines how many flowers can be formed and thus sets the limit for potential fruit number. Tomato inflorescences have a compound branching structure, and the transition rhythm from inflorescence meristem to floral meristem is a major basis for differences in inflorescence branching degree and flower number (Lippman et al., 2008). SINGLE FLOWER TRUSS (SFT), SELF PRUNING (SP), COMPOUND INFLORESCENCE (S), ANANTHA (AN), and related MADS-box transcription factors jointly regulate inflorescence branching and floral organ formation, thereby influencing the number and arrangement of flowers within the inflorescence (Graci and Barone, 2024). More recent studies further indicate that the SEPALLATA-class transcription factor SlMBP21 acts as a negative regulator, and that suppression of its expression can increase the number of flowers per inflorescence and improve fruit yield. At the same time, the miR156a-SPL13 pathway can alter the trade-off among inflorescence number, flower number, and fruit size by regulating inflorescence morphogenesis and lateral inflorescence formation. This indicates that the more inflorescences-more flowers-higher yield pattern in protected tomato production is not a simple linear relationship, but is regulated by the genetic network controlling inflorescence development and exists in dynamic balance with fruit size and resource allocation efficiency (Zhang et al., 2024b).

3.2 Effects of pollen viability and pollination conditions on fruit set rate

Although inflorescence number and flower number determine the upper limit of potential yield in protected tomato production, the actual fruit set rate largely depends on pollen performance and pollination conditions. Pollen production, pollen viability, germination ability, and pollen tube growth rate are all important reproductive indicators affecting tomato fruiting. Higher pollen viability is usually associated with higher fruit set rates and a greater number of fruits per plant. Under prolonged moderate high-temperature conditions, the number of inflorescences itself may not decrease significantly, but declines in pollen viability and the number of effective flowers per inflorescence directly restrict fruit formation, indicating that under fluctuating protected-environment conditions, male reproductive capacity is often a key constraint on stable yield. At the same time, high temperature typically reduces pollen viability and induces flower drop, whereas heat-tolerant materials can maintain higher pollen viability and thus form fruits more steadily under high-temperature conditions.

Although protected tomatoes are typical self-pollinating crops, their anther-cone structure means that effective pollen release often depends on a certain degree of vibration or external assistance. Under protected cultivation conditions, insufficient airflow, excessively high humidity, or environmentally induced stress on floral structures may all reduce pollen release, stigma pollination, and fertilization efficiency. The research conducted by Stroh et al. (2025) indicates protected cultivation conditions can significantly affect pollen quantity, and the first inflorescence often produces less pollen or poorer-quality pollen because of stress during the seedling stage or early reproductive stage. Meanwhile, mechanical vibration, bumblebee pollination, or other supplementary pollination methods can increase the amount of pollen received by the stigma, thereby improving fruit set rate and yield performance (Stroh et al., 2025). This indicates that improving fruit set depends not only on pollen quality, but also on the efficiency with which pollen arrives.