

Successful pollination is not equivalent to final fruiting; pollen germination and pollen tube penetration into the ovary are essential processes for initiating fruit development. Tomato fruit initiation is jointly influenced by pollination, pollen tube growth, and fertilization, and that the ability of the pollen tube to pass normally through the style and enter the ovary makes an independent contribution to subsequent fruit development. If pollen cannot germinate or cannot form a normal pollen tube, effective fruit development cannot be initiated even if the flower has already opened and apparent pollination has occurred (Kantoglu, 2024). Therefore, in protected tomato production, simply observing flower opening or pollen release is not sufficient to judge pollination quality; attention must also be paid to pollen germination ability and the continuity of fertilization from the style to the ovary stage.

### 3.3 Regulatory effects of environmental factors such as temperature and light on flower and fruit drop

Environmental factors such as temperature and light have decisive effects on flowering and fruit set in protected tomatoes, and their regulation of flower and fruit drop is especially sensitive during the flowering and young fruit formation stages. High temperature can interfere with pollen development, stigma and style function, and normal ovary development, thereby reducing fruit set rate and increasing the abscission of flowers and young fruits. Meanwhile, low night temperature can also inhibit pollen viability and pollen germination, induce parthenocarp, and promote pedicel abscission. Under heat stress, reproductive traits such as pollen viability, fruit set rate, pollen tube growth, and stigma exertion are all significantly impaired and are closely related to yield reduction. Therefore, flower and fruit drop in protected tomatoes is not simply a result of unfavorable climate, but rather the consequence of coordinated interference by environmental stress with floral organ development, hormonal balance, and the fertilization process (Figure 1) (Graci and Barone, 2024).

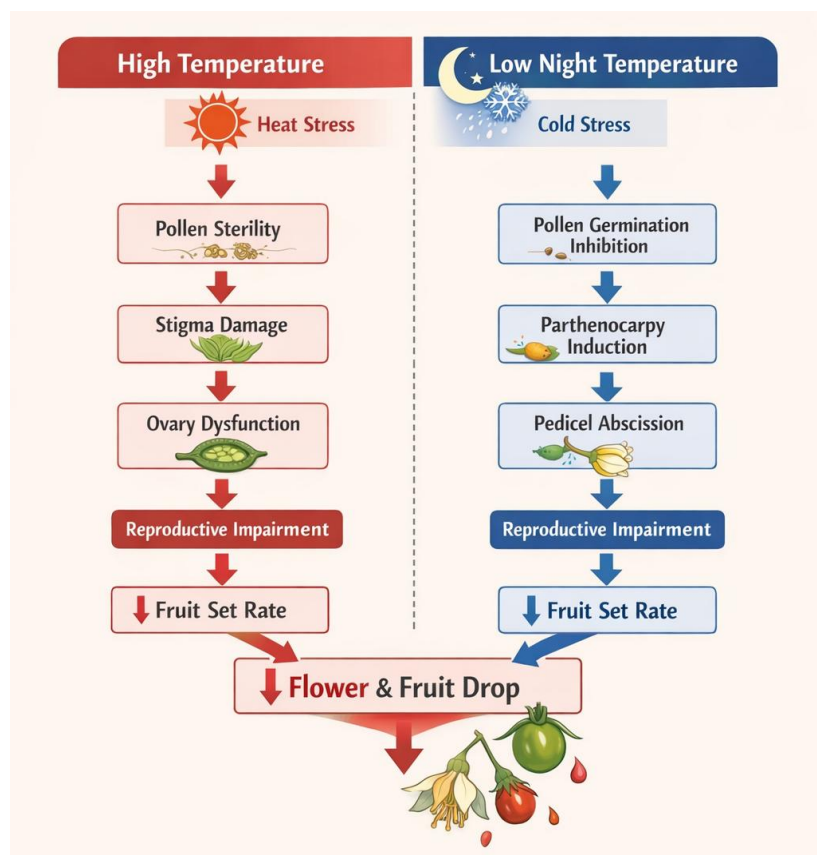


Figure 1 Effects of high temperature and low night temperature stress on reproductive processes and fruit set in tomato

Image caption: High temperature and low night temperature reduce fruit set in tomato by impairing reproductive processes, although through different pathways; High temperature mainly causes pollen sterility, stigma damage, and ovary dysfunction, whereas low night temperature primarily inhibits pollen germination and promotes pedicel abscission. Ultimately, both stresses lead to increased flower and fruit drop, thereby reducing yield formation and stability