expansion of global trade have further intensified and redistributed disease pressure, promoting the spread of new or more aggressive pathogen strains. Under these conditions, the use of host resistance has become one of the key strategies for sustainable tomato production. With the help of molecular markers, genomics, and CRISPR/Cas gene editing technologies, breeding programs are now focusing on developing new varieties that combine durable resistance to major diseases with high yield, early maturity, and good fruit quality (Rane et al., 2024).

This study explores how to integrate genetic disease resistance with strict quality requirements to support stable, efficient, and nutritious tomato production. It clarifies the global economic and nutritional importance of tomato and the scale of yield and quality losses caused by diseases in major production systems. It also systematically summarizes current research progress on major and emerging tomato diseases and reviews breeding and biotechnological strategies for developing resistant varieties. By linking disease resistance with yield stability, market standards, and nutritional value, this study outlines the pathways and prospects for achieving sustainable tomato production under multiple stress conditions.

2 Major Diseases Affecting Tomato Cultivation

2.1 Fungal diseases

Early blight is mainly caused by Alternaria solani and is one of the most destructive leaf diseases in tomato. It forms brown necrotic spots with typical concentric rings on leaves. In severe cases, it leads to heavy defoliation, reduced photosynthetic area, and can cause yield losses of up to 80% under favorable conditions (Ivanović et al., 2022). All aboveground parts of the plant can be affected. The disease becomes serious under conditions of high temperature, heavy dew, and high humidity.

Late blight is caused by Phytophthora infestans, a highly infectious oomycete disease that attacks leaves and fruits. It can destroy an entire crop within a few days. Cool and humid conditions favor its outbreaks, and historically it has caused total crop failure in Solanaceae crops (Oladokun et al., 2019).

Fusarium wilt is caused by *Fusarium oxysporum* f. sp. lycopersici. It is a soil-borne vascular disease that blocks the xylem vessels, leading to unilateral yellowing, wilting, and eventually plant death. The pathogen can survive in soil for a long time, and yield losses in susceptible varieties can reach 10%~80% (Li et al., 2024).

2.2 Bacterial diseases

Among bacterial diseases, bacterial wilt caused by *Ralstonia solanacearum* is one of the most destructive soil-borne diseases. It infects the vascular system, causing rapid and often irreversible wilting, stunting, and even death of plants, especially under warm and humid conditions. Contaminated soil, irrigation water, and plant residues allow the pathogen to survive for long periods, making it difficult to continue tomato cultivation in affected fields.

Bacterial spot is mainly caused by bacteria of the genus Xanthomonas. It is an important disease of leaves and fruits in both open-field and greenhouse production. The disease forms small water-soaked spots that later turn dark and scab-like, leading to leaf drop, reduced photosynthesis, and visible lesions on fruit surfaces, which lower market quality (Panno et al., 2021).

Because bactericides are often less effective against bacterial diseases and the pathogens can spread through seeds or water, control of these diseases is relatively difficult. Therefore, breeding resistant varieties and maintaining strict sanitation measures are particularly important.

2.3 Viral diseases

Tomato yellow leaf curl virus (TYLCV) is a whitefly-transmitted begomovirus and one of the most damaging tomato viruses worldwide. Infected plants show severe leaf curling, shortened internodes, chlorosis, and stunted growth, resulting in a sharp decline in fruit set and yield. Yield loss in susceptible varieties can approach 100% (Mugao, 2023).