

introduction Downy mildew is one of the most widespread and destructive plant diseases, impacting a wide range of crops worldwide. Farmers and agricultural researchers continue to study this disease to develop more effective management strategies and resistant crop varieties, as it remains a persistent threat to global food security and agricultural sustainability. Downy mildew is a pervasive threat to agriculture, primarily due to its ability to adapt to various environmental conditions and its high reproductive rate. Recent studies emphasize the role of climate change in exacerbating the prevalence of this disease, as warming temperatures and shifting humidity patterns create new hotspots for outbreaks. These pathogens are obligate parasites, meaning they require a living host to survive and reproduce.