EMERGING VIRAL DISEASES IN TOMATOES AND CUCURBITS: IMPLEMENTATION OF MITIGATION STRATEGIES FOR DURABLE DISEASE MANAGEMENT

Rendicontazione

Informazioni relative al progetto

VIRTIGATION

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Sito web del progetto

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Periodic Reporting for period 2 - VIRTIGATION (EMERGING VIRAL DISEASES IN TOMATOES AND CUCURBITS: IMPLEMENTATION OF MITIGATION STRATEGIES FOR DURABLE DISEASE MANAGEMENT)

Periodo di rendicontazione: 2022-12-01 al 2024-05-31

Sintesi del contesto e degli obiettivi generali del progetto

The VIRTIGATION project develops tools and strategies to protect tomatoes and cucurbits from plant viruses like begomoviruses and tobamoviruses, aiming to mitigate viral pandemics in crops across the EU and partner countries. It has established a network of 152 stakeholders to share and implement novel solutions. For diagnostics, new sequencing pipelines and the Genome Detective tool have been introduced to identify and analyze plant virus diversity rapidly. This tool also provides extensive information on virus populations, diversity, and distribution, aiding in the prediction and prevention of viral outbreaks. Preventive measures include breeding and genetic engineering were developed for resistance to ToBRFV and ToLCNV viruses. For protection against ToLCNDV, various plant extracts with insecticidal effect against virus-transmitting whiteflies were identified and tested in Belgium, Germany, Spain and Italy. For protection against ToBRFV, attenuated and natural mild isolates are being tested for their potential to immunize plants. Soil steaming, substrate solarization, and other protocols have been optimized to prevent tobamoviruses. Studies also focus on virus transmission via seeds, alternative hosts, and the impact of climate change on virus spread and host resistance.

Lavoro eseguito dall'inizio del progetto fino alla fine del periodo coperto dalla relazione e principali risultati finora ottenuti

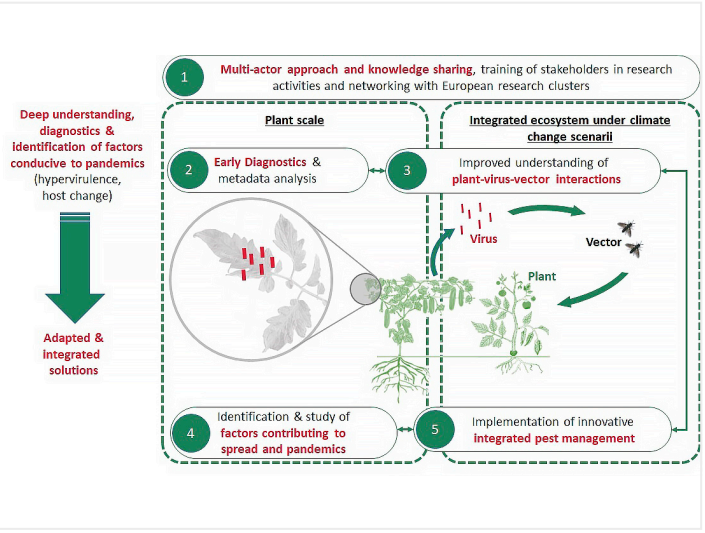
The multi-actor approach methodology has reached 152 officially affiliated stakeholders across different regions. Since the project's start, 409 participants attended 7 workshops in Germany, France, Spain, and Belgium; 299 students were trained, and 14 practice abstracts were published. Together with WP5, a questionnaire on whitefly control was distributed to 208 growers, aided by NKBs and national partners. The protocols for full-length sequencing of ToBRFV and ToLCNV with Oxford Nanopore Technology (ONT) were successfully implemented. A pipeline for accurate analysis of full-length virus sequences was implemented on the Genome Detective web platform by EMWEB. Samples of crops and weed hosts infected with DNA begomoviruses (Solanaceae and Cucurbitaceae) or RNA tobamoviruses (Solanaceae) were collected and sequenced by KUL to study virus diversity, distribution, and factors driving virus evolution. Wild tomato accessions asymptomatic and negative for ToBRFV were crossed with the susceptible variety Moneymaker. Tomato plants with high level of resistance to TYLCV were also asymptomatic to ToLCNDV. Tomato plants with high levels of resistance to betasatellites were developed. To understand the mechanism of resistance to whiteflies, transcriptomes of resistant cucumber lines are under study. To understand interactions between begomovirus deltasatellites and whiteflies, ten mutants of the deltasatellite SPLCD1 were designed. Infectious ToLCNDV clones were developed to test for resistance breakers. An infectious ToBRFV clone was developed. Transcriptome of early defence response to ToBRFV was generated. The seed-borne nature of ToLCNDV and ToBRFV was determined. Both viruses were detected in seeds from infected plants, but only ToBRFV was seed-transmissible. The role of alternative hosts in disease spread was assessed, revealing a limited number of wild hosts which allows effective disease control. Local whiteflies were better transmitters of ToLCNDV than invasive species, aligning with the

co-adaptation hypothesis. Host jump by ToLCNDV was linked to viral proteins AC2/AC3 on DNA-A and the DNA-B component. Higher temperatures increased ToLCNDV transmission efficiency. Mixed infections (ToLCNDV + WMV; ToBRFV + PepMV) exacerbated plant damage in tomatoes and cucurbits. In WP5, tested plant extracts showed insecticidal effects against whitefly nymphs and adults comparable to commercial bio-insecticides and safer to beneficial insects. For ToBrFV, pre-infection with two mild natural and four attenuated isolates were demonstrated to protect tomato plants from ToBRFV. The long-term stability of these isolates is under evaluation. Protocols for soil treatment, including steaming at > 90 °C, were optimized and proved effective in eradicating the model tobamovirus TMV. This work has increased knowledge about ToBRFV.

Progressi oltre lo stato dell'arte e potenziale impatto previsto (incluso l'impatto socioeconomico e le implicazioni sociali più ampie del progetto fino ad ora)

The VIRTIGATION project established a multi-stakeholder network to enhance communication and collaboration among stakeholders, providing guidelines, tools, and best practices for a multi-actor approach. It trained 200 people and engaged 500 stakeholders. Advanced pipelines for full genome DNA and RNA virus sequencing were implemented using the Genome Detective web platform, allowing detailed profiling of viral genomes, including reconstruction of the 5' and 3' ends of ToBRFV. This data aids in understanding virus populations, diversity, origins, distribution, and factors driving virus emergence and evolution. Mutations associated with mild symptoms for cross-protection were identified for developing alternative crop protection strategies. Points of entry can be deciphered using phylogenetic analysis of full viral genomes which will enable policies to reduce virus introductions in production zones. The project also developed tomato plants with high resistance to TYLCV and ToLCNDV, including resistance to betasatellite, essential for seed companies' breeding programs. Insights into whitefly vector resistance complement breeding efforts to integrate whitefly and virus resistance into commercial tomato varieties. Identifying key plant defense genes and applying resistance inducers can improve plant disease management. The project's findings on future climatic scenarios, particularly high temperatures, will help predict the impact on virus severity and transmission, guiding crop production strategies. Knowledge of seed-transmission nature of ToLCNDV and ToBRFV is critical for preventing their spread and informing government quarantine policies. Understanding factors determining viral host jumps can help predict and prevent such events. The project tested several natural extracts effective against the whitefly, promoting alternative pest control methods and reducing conventional pesticide use, aligning with FarmToFork objectives. Updated hygiene protocols considering energy efficiency will mitigate Tobamovirus outbreaks. Integrated pest management strategies for Tobamo and Begomoviruses will be validated, providing growers with effective virus and vector management tools, reducing losses in tomato and cucurbit value chains. Enhanced knowledge of ToBRFV natural isolates will help growers quickly identify new outbreaks and mitigate damage.

Biopesticide testing in Italy (WP5)



VIRTIGATION overall concept with associated objectives

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