PATAFEST

PRACTICE ABSTRACT

Candidatus Liberibacter solanacearum (CLso): Presence in Ecuador and Implications for European Plant Health Security

A plant disorder known as “psyllid yellows”, significantly impacted potato production in North America around 1920, an issue initially attributed to the potato psyllid *Bactericera cockerelli*, due to the lack of molecular diagnostic tools. Between the 1990s and 2011, the zebra chip disease—caused by *Candidatus* Liberibacter solanacearum (CLso) and transmitted by the potato psyllid—spread from Mexico throughout the US. Subsequently, CLso and the potato psyllid quickly invaded New Zealand within 4 years, and the potato psyllid has recently been detected in Australia.

Although phytoplasmas were first confirmed in Ecuadorian potato crops in 2015, they had been documented in Bolivia since 2005 and Peru since 2009. Even if CLso was officially reported in Ecuador in 2020, its symptoms were observed in 2014 and spread to the southern highlands by 2020. In 2021, the threat was officially reported in Colombia and Peru, spreading 800 km south in Peru within only 2 years. Similar symptoms in Ecuador, Colombia, and Peru stem from single or mixed CLso and phytoplasma infections, also reported in New Zealand and Mexico. Scientific publications now predict the pest could impact global potato production, alerting Asia to potential incursions from Australia.

PataFEST project protects European potato crops from this potential potato psyllid invasion through the search for pest-resistant potato genes, building early detection tools, testing eco-friendly insecticides, conducting genetic studies on the transmission pathways of CLso, and training European farmers to identify and monitor the potato psyllid to protect their crops from possible intrusions.

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PRACTICE ABSTRACT

Optical sensors for early diagnosis of pathogen-infected potatoes

Early diagnosis of potato diseases can help growers and advisors act sooner and reduce crop and storage losses. In PataFEST, potato plants and tubers from six commercial varieties were analysed using high-throughput phenotyping with optical sensors, including RGB and fluorescence imaging, to detect stress caused by key postharvest pathogens: black dot, *Fusarium*, and silver scurf.

The study identified several morphological and physiological indicators that distinguish healthy from infected plants before severe symptoms develop. Across infections, diseased plants showed reduced size and growth, lower greenness, increased browning or grey tones, and changes in fluorescence-related parameters, indicating reduced photosynthetic performance. Black dot was associated with growth reduction, browning, and changes in photosynthesis. Fusarium also induced small plants, rapid and severe necrosis, and a decline in fluorescence. Similarly, silver scurf reduced growth and photosynthetic activity. In tubers, distinct colour classes also helped distinguish Fusarium from black dot infection, with Fusarium associated with grey or brown-grey tones and black dot with several shades of brown.

These results provided 51 phenotyping traits as a basis for early, non-destructive diagnosis of potato health problems and for future screening tools to identify resistant genotypes and infected material more reliably. This can improve crop monitoring, storage management, and decision-making in potato production.

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Searching for Potato resistance to pests and postharvest diseases

Our aim is to establish a Potato Resistance Gene Catalogue (Rgenes) and identify genetic variants associated with the response to post-harvest diseases and the quarantine Zebra Chip disease to be used for breeding resistant varieties.

Where to search

By searching in different NCBI databases[1], we collected several Rgene DNA sequences, which we mapped against the Potato genome: we found a total of 747 already known Rgenes, but we also identified 750 potentially new ones, based on collocated Rgene homologues from the different searches. To analyse the effect on disease resistance of genetic variants, such as single nucleotide polymorphisms (SNPs), through Genome-wide association study (GWAS), over 350,000 SNPs were compiled, mapped also to the genome, and 10,500 SNPs within our set of Rgenes were identified.

Disease tolerance

For post-harvest diseases, we measured the susceptibility of 350 lines to Silver scurf, Dry rot and Black dot. Some proved to be more tolerant such as “Bafana” to dry rot or “Innovator” to silver scurf. Regarding Zebra Chip disease, we assessed the oviposition rate of the disease vector, the psyllid *Bactericera cockerelly*, in 150 varieties.

Genetic markers

We genotyped the SNPs previously catalogued in all 500 varieties by using two different genotyping techniques: 35K Potato SNP array and Single Primer Enrichment Technique (SPET) to discover new SNPs non-catalogued yet within Rgenes. We are now performing GWAS to identify genetic variants associated with potato resistance to the four diseases. Once identified, these genetic markers will be used to breed new potato varieties with better resistance to pests and postharvest diseases.

1 National Centre for Biotechnology Information

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PRACTICE ABSTRACT

Integrating portable VOC sensors into postharvest monitoring: sensor types, usability, and operational applications

Potato fungal infections during storage caused by *Fusarium Sambucinum* can lead to significant losses and are often detected too late. This work presents a practical solution using portable sensors to detect early signs of infection through air monitoring in potatoes during their storage.

Two key gases (volatile organic compounds, usually known as VOCs) are used as indicators. Methanol (MeOH), which increases when infection starts, and dimethyl disulfide (DMDS), that only appears in infected potatoes. For this reason, controlling the level of these gases will provide information about the health status of stored potatoes and support decision-making by operators. Two low-cost sensors have been developed to detect these gases and estimate their levels in real time. These sensors are based on selected materials that attract and interact with the target gases. This interaction changes their conductivity, which is measured to determine MeOH and DMDS levels.

The system sends an alert when abnormal MeOH levels are detected or when DMDS appears. When this alert is triggered, workers can quickly check the stored potatoes and remove affected ones, preventing the spread of infection. This solution is easy to use without the need for complex handling, supports continuous monitoring, and helps reduce losses, improve storage management, and increase profitability for producers and storage operators.

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PRACTICE ABSTRACT

Development of a smart digital tool for real-time detection of potato diseases during storage

Potato storage diseases can cause significant economic losses for farmers and storage operators due to product degradation, reduced quality, and food waste. Early detection of diseases during storage is essential to prevent the spread of pathogens, optimise storage conditions, and improve the commercial value of potatoes.

Within the PataFEST project, a digital platform combined with portable sensor devices has been developed to support real-time detection and monitoring of potato diseases during storage. The solution focuses on identifying changes associated with harmful pathogens by analysing of Volatile Organic Compounds (VOCs) and environmental conditions in potato warehouses, allowing earlier detection before visible symptoms appear.

The digital tool allows farmers and storage managers to collect, visualise and analyse data directly from portable devices in a simple and fast way. Artificial intelligence tools process the information obtained from the sensors to support disease monitoring and improve the interpretation of storage conditions. The platform also supports cloud-based data storage, traceability, and remote monitoring to enable faster decision-making and improved disease surveillance, while reducing the need for manual inspections.

This low-cost and user-friendly digital solution helps reduce storage losses, improve product quality and support more sustainable potato management practices by enabling faster interventions, optimising warehouse management and reducing unnecessary waste during the postharvest stage.

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AI surveillance models to anticipate emerging pest risks in potato crops under climate change

Climate change is creating increasingly favourable conditions for devastating pests, currently present in the Americas or Asia, to reach Europe. Zebra Chip disease, caused by the bacterium *Candidatus* Liberibacter solanacearum, has already wiped out entire potato harvests in Ecuador. Until now, European farmers and advisors have no tools to assess whether their local climate could support its arrival.

What has been achieved?

Within PataFEST project, FUNDITEC has developed two complementary AI-based tools.

The core component is a climate surveillance model that analyses historical and current weather data to identify whether conditions in a European region are becoming increasingly similar to those in areas where the pest is already established. It also simulates the speed and patterns of the disease spread across nearby areas, reflecting real-world expansion routes. In testing, the model correctly identified risk situations in over 87% of cases.

As a complementary tool, an image analysis model has been developed that detects common tuber and plant diseases, such as dry rot, black dot and silver scurf, from a simple smartphone photo, with an accuracy of over 95%.

What does this mean in practice?

Agronomists, cooperatives and plant health authorities can consult updated risk maps to anticipate incoming threats and act preventively. In the field, farmers can instantly detect diseases without sending samples to a laboratory. Together, these tools mean fewer crop losses, fewer emergency treatments and better-informed decisions throughout the growing season.

As the climate continues to change, the surveillance model will be updated to reflect new risk scenarios, providing ongoing decision support for the European potato sector.

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Using bio-based protective coatings to control postharvest potato diseases and reduce chemical treatments in storage facilities

Potato storage is often affected by postharvest diseases such as dry rot, black dot and silver scurf, mainly caused by fungi (*Fusarium, C. coccodes*, and *H. solani*, respectively), leading to losses of up to 30%. Control is usually based on chemical treatments, which can negatively affect the environment, soil health, and food safety. In addition, the rise of resistant pathogens and increasing consumer demand for cleaner, chemical-free food have highlighted the need for sustainable alternatives.

PataFEST develops bio-based edible coatings as a solution to protect potatoes against postharvest diseases and maintain their quality.

Main practical outcomes:

- **Advanced biocontrol solution**: edible coatings made from natural lipid-based materials, incorporating beneficial microorganisms and enzymes with antifungal activity.
- **Quality preservation**: the coatings help maintain potato quality attributes such as weight and moisture loss and provide barrier properties.
- **User-friendly application**: the solution is designed to be applied by simple dipping, without complex equipment.
- **Farmer and consumer benefits**: reduced losses, lower chemical use, and increased profitability, while meeting demand for safer, high-quality food.

Overall, this solution provides an effective, easy-to-use, and sustainable alternative for controlling postharvest diseases.

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Natural Plant-Based, Chemical-Free Solutions for Sustainable Potato Pest Prevention

Developed within PataFEST project, the TechPok is an innovative water-based spray formulation designed for sustainable aphid management in potato crops. It combines natural fatty acids with calcium carbonate particles, offering an eco-friendly alternative to synthetic pesticides. The system provides dual-action physical defence. The fatty acids create a rougher surface that disrupts the aphids' ability to move, while the integrated calcium carbonate particles harden the coating into a tough shield. This physical barrier effectively hinders them from piercing the plant tissue. Tests prove that calcium carbonate makes the surface twice as tough in protecting the plant as fatty acids alone.

Practical Implications & Recommendations

- Sustained Protection: The coating provides immediate defence, significantly reducing aphid activity and colonization after application.
- Environmental Stability: Designed for field conditions, the coating demonstrates high stability under environmental stresses, retaining its hydrophobic surface properties after exposure to UV radiation, elevated (50°C) and sub-zero temperatures (up to -20°C).
- Zero Crop Harm: The natural components ensure healthy crop development. Field trials confirm that treated plants show growth comparable to water-treated controls, guaranteeing no negative impact on crop yields.
- Ease of Application: The formulation can be applied using standard agricultural spraying equipment, enabling easy integration into existing farming practices as a cost-effective solution.

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Plant-Based Clay Spray for Sustainable Pest and Disease Prevention

Sap-sucking pests such as aphids and psyllids can build populations fast and spread diseases. We develop sprayable, natural clay-based formulations designed for straightforward foliar application, loaded with essential oils as bio-based actives that combine two actions:

- The clay acts as a physical barrier, forming a particulate foliar film that reduces pest settling, feeding, and stylet probing.
- The clay also acts as a carrier that can release essential oils over time.

In laboratory bioassays, treated leaves showed up to a 90% reduction in aphid population within 24 hours compared to the control, accounting for both initially introduced aphids and newly produced nymphs.

Early whole-plant greenhouse observations over about one week showed promising repellent and anti-feeding effects.

In PataFEST, this approach is relevant for pest protection, such as the potato psyllid, which vectors *Candidatus* Liberibacter solanacearum and causes zebra chip disease, resulting in major yield and quality losses.

PataFEST is now testing different concentrations of foliar spray to avoid unnecessary product waste or plant damage.

The formulation is designed for practical farm use as a stable concentrate with simple ‘dilute-and-spray’ foliar application using standard agricultural equipment. The use of naturally derived ingredients already established in agriculture is expected to facilitate a relatively straightforward regulatory assessment, although requirements still vary by country.

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Bio-based soil amendments from aquaculture residues to enhance potato health and disease resilience

This project explores the use of calcium carbonate derived from aquaculture shell waste (clams and oysters) to develop innovative materials for delivering essential soil nutrients—phosphorus, iron, zinc, molybdenum, and boron. The aim is to enhance crop nutrition while supporting potato plant health and disease resilience. In addition, the valorisation of shell waste promotes circular economy principles, reduces reliance on synthetic inputs, and lowers environmental impact. Various preparation methods were evaluated to optimize nutrient loading and stability. Milling-based approaches showed superior performance for phosphorus and iron. Further analyses assessed nutrient chemical forms to determine their bioavailability. Multi-nutrient formulations were also developed to better reflect field conditions, showing good agreement between expected and measured nutrient content. Moreover, ongoing experiments aim to comprehensively evaluate the effects of the developed bio-based soil amendments on variations in microelement concentrations in both leaf and tuber tissues, as well as their influence on plant physiological status. Particular attention is being given to the role of these amendments in modulating tuber susceptibility to post-harvest pathogens, with the objective of assessing improvements in crop quality, storage performance, and overall resilience. This solution offers farmers a sustainable and practical alternative to conventional fertilizers and can be applied using standard practices. Overall, this approach provides a cost-effective, user-friendly, and sustainable strategy for nutrient delivery in potato production.

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Engaging urban gardeners in testing fertiliser

Within PataFEST project, we conducted citizen science activities with urban gardeners in Berlin. The aim of the activities was to test a fertiliser based on oyster shells developed in the project. The fertiliser and its application were introduced during a workshop at the Stadtgarten Lichtenberg (urban garden in Berlin-Lichtenberg) in May 2025, where we demonstrated how to use the fertilizer on fields and in pots. Afterward, participants took fertiliser samples to test at home. Since not all participants were growing potatoes, some used the fertiliser on other plants, such as tomatoes, basil, and even a banana tree. They sent their observations in the form of pictures and short descriptions. Participants reported that plant leaves (potato and others) were growing at a much faster rate when using the fertiliser, and diseased plants recovered after the application. These results enriched the otherwise potato-focused project by presenting results from other plant types, thanks only to the curiosity and commitment of the participants.

Overall, the fertiliser tests were well received, and participants were motivated to share their observations, especially when asked in person. In comparison, where communication was primarily via mail, fewer participants responded. This highlights the importance of active and in-person communication with local stakeholders. Another takeaway from the CS activities is the importance of engaging citizens early on and making use of existing networks. Higher participation rates can lead to more accurate results and raise awareness about the issues that the project aims to address.

Finally, we also appreciated being able to visit a garden and getting to know the gardeners.

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