As the global population grows, the demand for food is increasing, placing significant pressure on agriculture to produce higher yields. Plant diseases caused by bacterial and fungal pathogens are a major threat, reducing crop quality and quantity, and causing significant economic losses. Early detection of these diseases is critical to prevent their spread and protect food supplies. However, traditional diagnostic methods, such as DNA-based tests or serological assays, are often expensive, time-consuming, and unsuitable for large-scale, early-stage detection. There is an urgent need for innovative, practical tools that can early detect infections early and help farmers manage plant health more effectively.

This project focuses on non-target screening for diagnosing plant diseases and evaluating soil health. The approach relies on analysing volatile organic compounds (VOCs)—chemicals emitted by plants and soil that carry important information about their physiological state and health. These VOCs can act as “fingerprints” for detecting infections at early stages, often before visual symptoms appear.

The research will employ advanced analytical tools, including gas chromatography (GC), electronic noses, and real-time PCR. By studying crops like carrots and onions, the project aims to detect changes in VOC emissions linked to bacterial and fungal infections. Additionally, the research will investigate how soilborne pathogens, which persist in soil for years, affect soil VOC profiles. Chemometric methods, which are powerful data analysis techniques, will be used to process complex datasets, enhancing the precision and reliability of the diagnostic tools.

The results of this project will make a significant impact on both the field of plant pathology and the broader scientific discipline of analytical chemistry. By demonstrating the efficacy of non-target VOC screening methods, including GC-IMS, GC-FID, and electronic noses, the project will lay the groundwork for rapid, cost-effective plant disease diagnostics. The portability of technologies like electronic noses will facilitate their adoption in diverse agricultural settings, enabling real-time screening measurements and quick response to faced threat, by managing the infected crops (e.g. elimination or selling into the animal feed market), controlling disease spreading by increasing ventilation or changing storage conditions.

Furthermore, the investigation of soil volatile profiles provides a new insight into plant disease diagnostics, emphasizing the importance of soil-plant interactions in disease progression. These findings will contribute to a more integrated understanding of plant health and deepen the knowledge of soil microbiomes, volatilomes, stress responses, and sustainable disease management practices. Microbiological studies will also provide new knowledge on plant pathogens and their development in stored crops and in soil.

The comparative analysis of multiple analytical technologies will advance the field of analytical chemistry by providing valuable insights into various tools performance in non-target applications. This research is expected to drive innovations in VOC analysis, with implications that extend beyond agriculture to environmental monitoring, food safety, and other fields reliant on volatile compound analysis.