OPTIMISING BIOSECURITY TESTING USING NEXT GENERATION SEQUENCING

In contemporary agriculture, rapid and secure access to new plant genetic stocks is critical for the success and sustainability of primary industries. The ability to quickly adapt to new global market opportunities and access innovative plant varieties is key to remaining competitive.

KEY POINTS

- Rapid access to new and safe plant genetics is vital to keep Australia's local industry competitive.
- Next Generation Sequencing (NGS) adoption promises faster access to new genetic material, cost savings, increased imports, and agile responses to market opportunities in agriculture.
- Current plant import processes are costly and inflexible due to extended quarantine periods.
- NGS offers a faster, versatile, and reliable method for pathogen detection.
- Collaborative research supports NGS as a practical solution for improving quarantine testing.
- Traditional diagnostics have limitations.

Currently, when imported plant material arrives in Australia, it spends up to three years in Post Entry Quarantine (PEQ) facilities, primarily for pathogen testing. This delay not only hampers the industry's flexibility but also adds significant costs.

Traditional pathogen testing methods are often time-consuming, resource-intensive, and can yield ambiguous results. This is where Next Generation Sequencing (NGS) steps in as a game-changer. NGS provides a scalable, robust, accurate, and rapid diagnostic platform, promising to expedite 'plant health' screening and reduce quarantine time.

A collaborative Horticulture Innovation Australia project spanning multiple crops has shown that NGS is a feasible alternative that will reduce time and improve accuracy of quarantine testing.

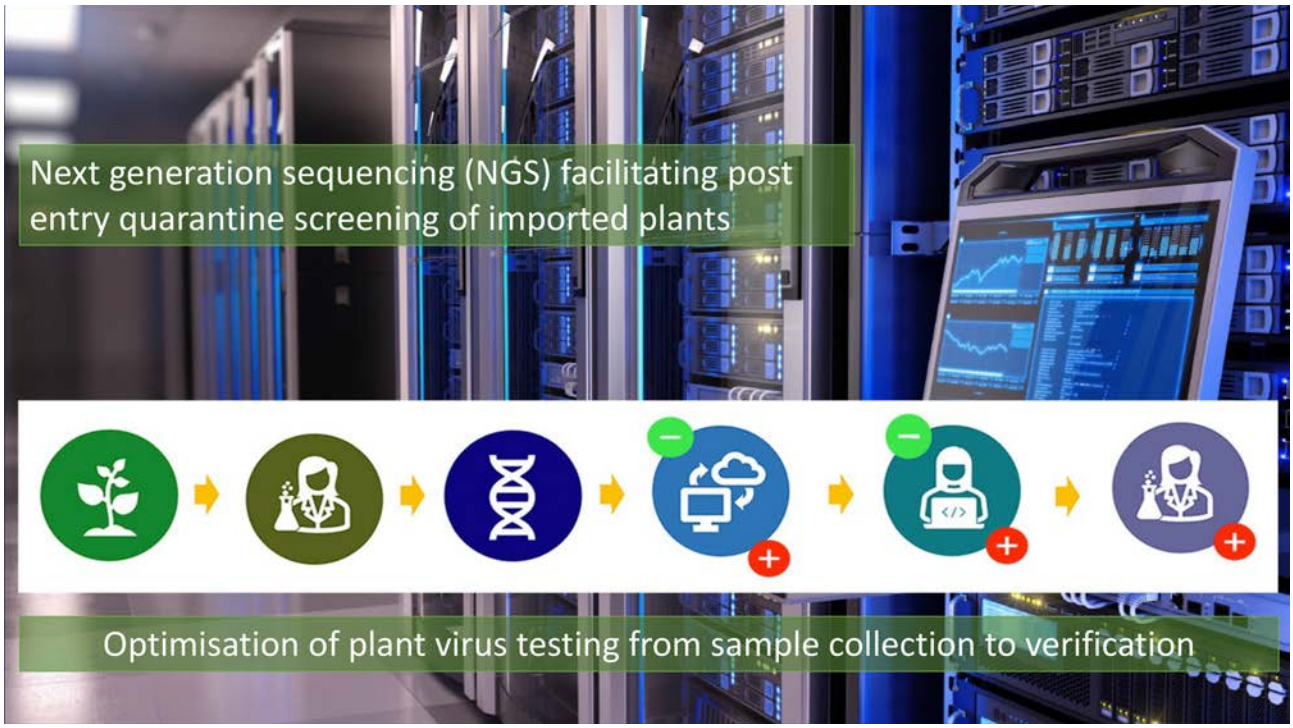
The project *Improving Plant industry access to new genetics through faster and more accurate diagnostics using next-generation sequencing* (MT18005) investigated the application of advance gene technology – known as Next Generation Sequencing (or NGS) to screen imported horticultural plant materials in PEQ.

BIOSECURITY RELEVANCE

Biosecurity measures are primarily designed to prevent the introduction of exotic plant pests. Traditional diagnostic methods, such as tissue (serological) or molecular analyses, rely on prior knowledge of the pathogen's genetic blueprint. However, these methods are often specific to certain pathogens, limiting their versatility.

In contrast, non-specific assays like electron microscopy, woody indexing, or visual inspection do not require prior knowledge but can lead to ambiguous detections. Typically, they provide limited diagnostic certainty, mainly categorising organisms at the broad level, which is not reliable when looking for diseases.

Additionally, most traditional tests cannot detect multiple pests in a single test, causing delays in the quarantine process and hindering the industry's ability to respond promptly to emerging market opportunities.



NGS AND PROJECT OUTCOMES

Plant viruses and viroids are tiny organisms that harm plants and detecting them when a plant is showing no symptoms can be challenging. NGS technology has changed the way we find and identify these hidden pest and diseases. When NGS is combined with computer analysis (bioinformatics), detection of known viruses is quick and accurate. Better still, new threats can be detected.

Large scale side-by-side trials of PEQ and NGS protocols demonstrated the benefits of NGS to detect virus-free plants and plants infected with pesst of biosecurity concern. NGS is informing and guiding the effective use of resources at PEQ to facilitate and optimise quarantine testing and decision making.

Technical advances in NGS diagnostics for plant viruses have led to the adoption of the technology for routine testing in prunus, rubus, strawberries, and ornamental grasses.

The team continues to use the technology for a broad range of plant species including potatoes providing industries the option to opt-in to use NGS along with other existing PEQ testing protocols.

The project team has also made significant progress using NGS to detect and precisely identify bacteria in several crop species, trialling two different approaches to using the technology.

The first approach involved collecting all the genetic information from a sample of the pest – essentially gathering a complete picture of its genetic makeup. The second approach focused on specific regions of genes that are associated with known harmful bacteria.

Their research yielded promising results. When they used the first method (whole genome sequencing), they were able to produce high-quality genetic information. Importantly, this method revealed results that were clouded by interference from genetic material of other organisms.

The targeted capture approach was successful in detecting bacteria that are challenging to cultivate in a laboratory.

Based on these findings, they have developed a draft policy paper to promote the use of NGS technology to test bacterial pests in PEQ facilities. However, it will likely take a few years for NGS to become routine in testing for bacteria. Currently, NGS is only used for detecting plant viruses and viroids.

The project, carried out in close partnership with the Department of Agriculture, Fisheries, and Forestry, has successfully facilitated the policy acceptance and operationalisation of NGS for routine quarantine testing of plant viruses at PEQ facilities. This achievement is expected to enhance Australia's biosecurity system, safeguarding domestic plant industries from exotic pests.

Moreover, it will enable plant industries to gain accelerated access to new plant genetics, ultimately providing them with improved opportunities in high-value markets. This transformative capability promises to revolutionise biosecurity, ensuring the protection of domestic plant industries while opening access to global opportunities.

GOOD NEWS FOR GROWERS

NGS has already been successfully employed for the detection and identification of numerous plant viral and bacterial diseases. This technology even leverages the innate plant immune response to detect and reliably assemble viral genomes, further enhancing its efficacy in PEQ facilities.

The implementation of NGS in plant quarantine and biosecurity procedures brings a host of benefits to growers and the agriculture industry including:

1. **Faster access to new genetics:** with NGS, the industry gains rapid access to new plant genetic stocks, allowing for quicker incorporation of innovative plant varieties.
2. **Lower costs for quarantine testing:** NGS streamlines the testing process, reducing resource and time requirements, thus lowering overall quarantine costs.
3. **Option to import a larger volume of plants:** the efficiency of NGS enables the importation of a larger volume of plants, expanding the possibilities for growers and agribusinesses.
4. **Ability to respond to emerging market opportunities:** NGS empowers the industry to quickly adapt to emerging market opportunities, ensuring a competitive edge in the global market.

NGS technology relies on the use of super computers to process the large amount of genetic data collected from imported plant species.

All plant industries importing new genetic material through PEQ can opt-in to use the NGS technology along with other existing quarantine testing procedures.

A further advantage of the NGS is its ability to detect pests that may be endemic, enabling industries to make an informed decision on building a business portfolio around new genetic imported material.

WHAT'S NEXT

As the project progresses, further R&D is underway to improve the use of the NGS technology for the diagnosis of plant pests, particularly for challenging commodities such as imported seeds.

The team is now developing molecular techniques to facilitate the generation of virus-free plants when high value plants are imported to Australia, but these may be infected with one or more viruses of biosecurity concern.

FURTHER READING

The final report is available to download from the Hort Innovation website.

Hort Innovation POTATO – FRESH FUND
This project has been funded by Hort innovation using the potato – fresh research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

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