Murdoch UNIVERSITY

2017 RESEARCH FINDINGS

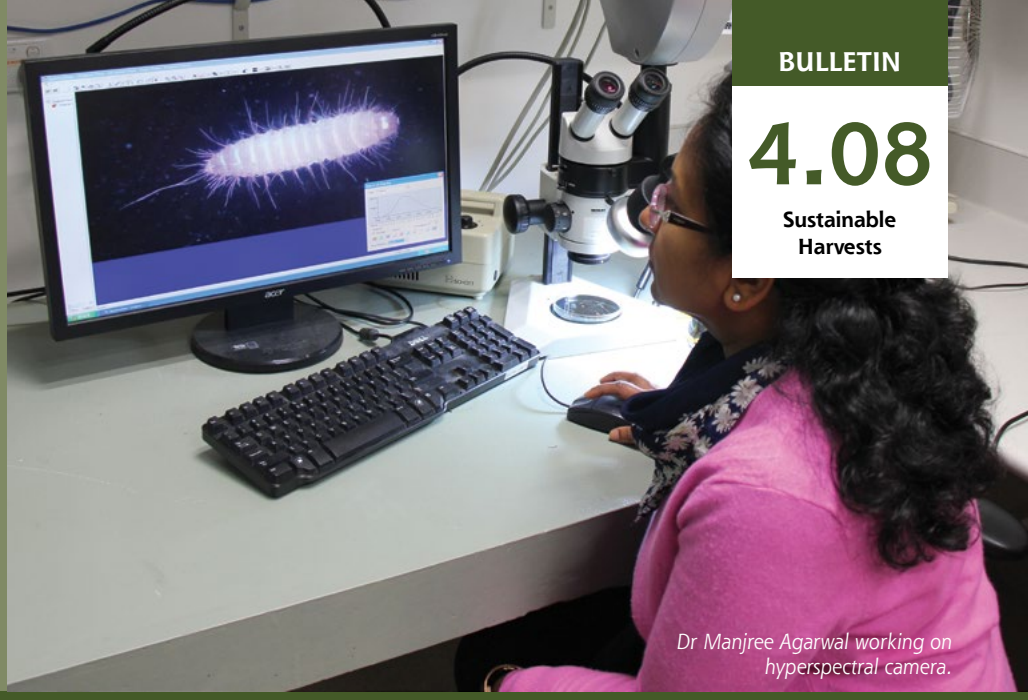
in the School of

VETERINARY & LIFE SCIENCES

BULLETIN

4.08

Sustainable Harvests



Dr Manjree Agarwal working on hyperspectral camera.

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What's that beetle? Diagnostic tools for exotic khapra beetle

Khapra beetle (*Trogoderma granarium*) is one of the major quarantine pest of Australia. The economic consequences of an incursion of this species would be very serious as the pest is difficult to control by existing methods, threatening an estimated $1.83 billion in Australian annual export revenue. Australia would also lose our premium (Khapra-free) market reputation, which is valued at $4.9 billion. The risk of incursion and establishment of this species is increasing significantly as Australia continues to grow imports of grain, grain products and animal products.

Accurate and reliable identification becomes very difficult as Khapra beetles morphologically resemble other native *Trogoderma* species. Therefore, development of appropriate preparedness tools will significantly minimise potential impacts of a khapra beetle incursion in WA.

This collaborative project between Murdoch University and Department of Primary Industries and Regional Development (DPIRD) aims to develop a new diagnostic system for khapra beetle using a combination of traditional morphology, molecular biology, and visible near-infrared hyperspectral (VNIH) imaging methods to address biosecurity surveillance and identification gaps for khapra beetle. Through the project, we have developed an inventory of unique DNA sequences and VNIH spectra for khapra beetle, warehouse beetle, and other native *Trogoderma* species that could potentially be mistaken for khapra beetle.

Rice infested with khapra beetle.

Methods and results

We are developing two major diagnostic tools to distinguish native *Trogoderma* species from khapra beetle collected from different geographical regions of the world:

1. Visible and near-infrared hyperspectral (VNIH) imaging

VNIH imaging is a rapid non-destructive and reagent-less means of monitoring physical and morphological characteristics simultaneously. Hyperspectral imaging systems can record images at hundreds of contiguous wavelengths (narrow spectral resolution) in the form of a hypercube (three-dimensional hyperspectral data). The technique involves identifying critical wavelength signatures for each species in the 400–1000 nm range. Because of the biological variations among test insects, each sample reflects and absorbs electromagnetic energy at a specific spectral band. The intensity value of each pixel of the picture corresponds to its spectral value at a specific spectral band. The intensity level of the picture is then used to characterise chemical and physical variations in the insect.

After the characteristic wavelengths have been identified, the images corresponding to the optimal wavelength for each insect sample are selected for feature extraction. This technique has potential as a diagnostic tool to identify khapra beetle, including different geographical strains.

TOP: Grain sampling. ABOVE: Unloading of grain.

2. Molecular evaluation

Conventional PCR, real-time PCR, and DNA sequencing methods were used to distinguish between different species. DNA is extracted from morphologically verified khapra beetle populations, to be compared with native Australian *Trogoderma* species, warehouse beetle, and other related pest Dermestids. In addition, samples from a national *Trogoderma* trapping program, recent surveys across the WA wheat belt, and Gnangara and khapra beetle material from different geographical regions of the world, provide a comprehensive library of material to draw on for molecular and morphological comparisons, and the collation of unique DNA profiles. This part was done by the project team based at DPIRD.

Conclusions and recommendations

This research will help protect growers and bulk handlers from khapra beetle by establishing foundation work for developing effective high throughput diagnostic techniques for khapra beetle, enabling early detection of exotic species. These tools will help improve insect resistance management, targeting control action. This will help 'future-proof' in the event of a khapra beetle infestation, ensuring Australia meets its international plant protection obligations when responding to pest incursions. ■

ABOVE: Grain silos, Western Australia.

More information

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Acknowledgements

This is funded by Boosting Biosecurity Defences project, supported by Royalties for Regions and the Department of Primary Industries and Regional Development. We are thankful to all the project team members from DPIRD and UWA.

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CRICOS Code: 00125J