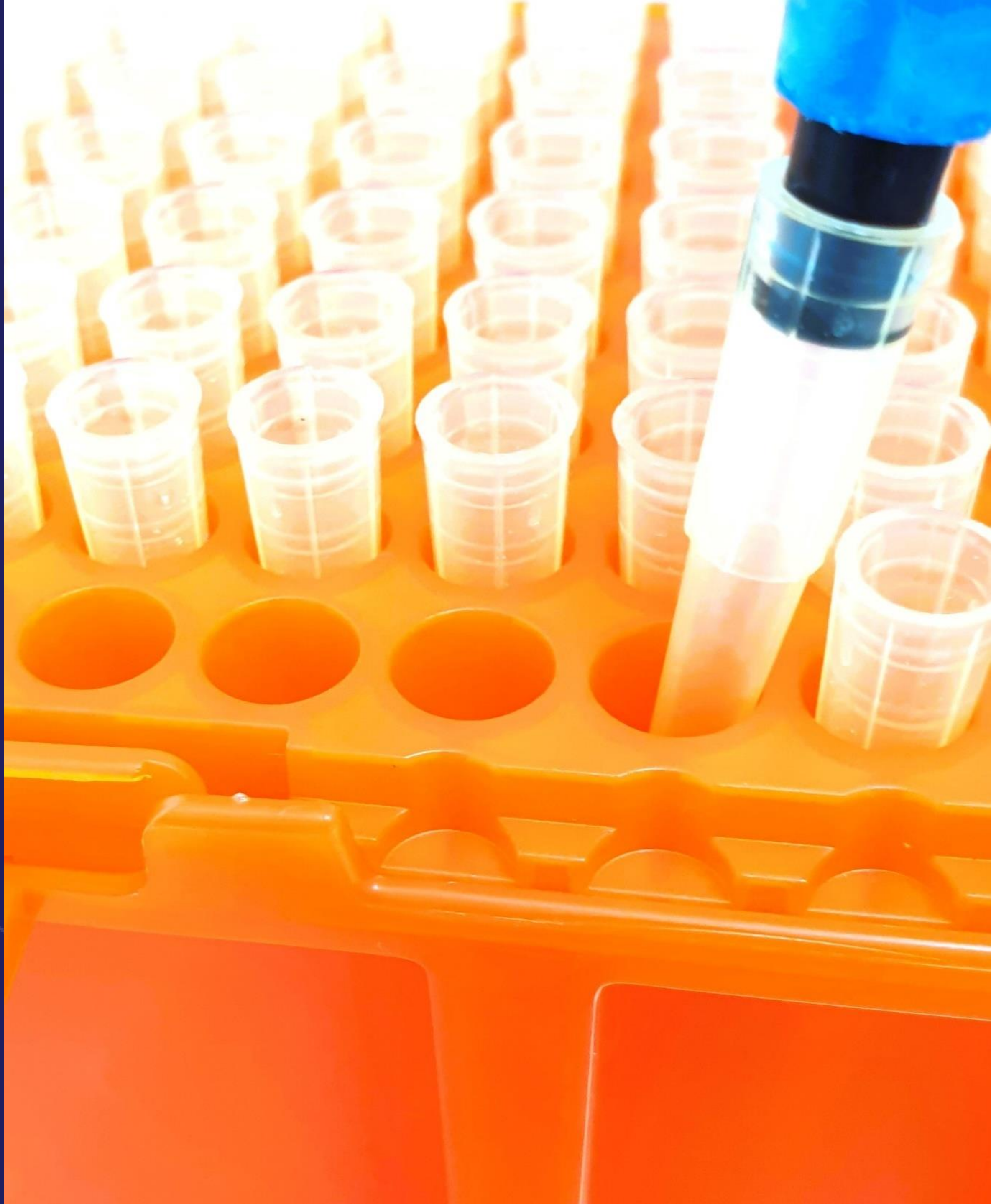
Genetic investigations of the defence responses of mango cultivars to safeguard the Australian mango industry:

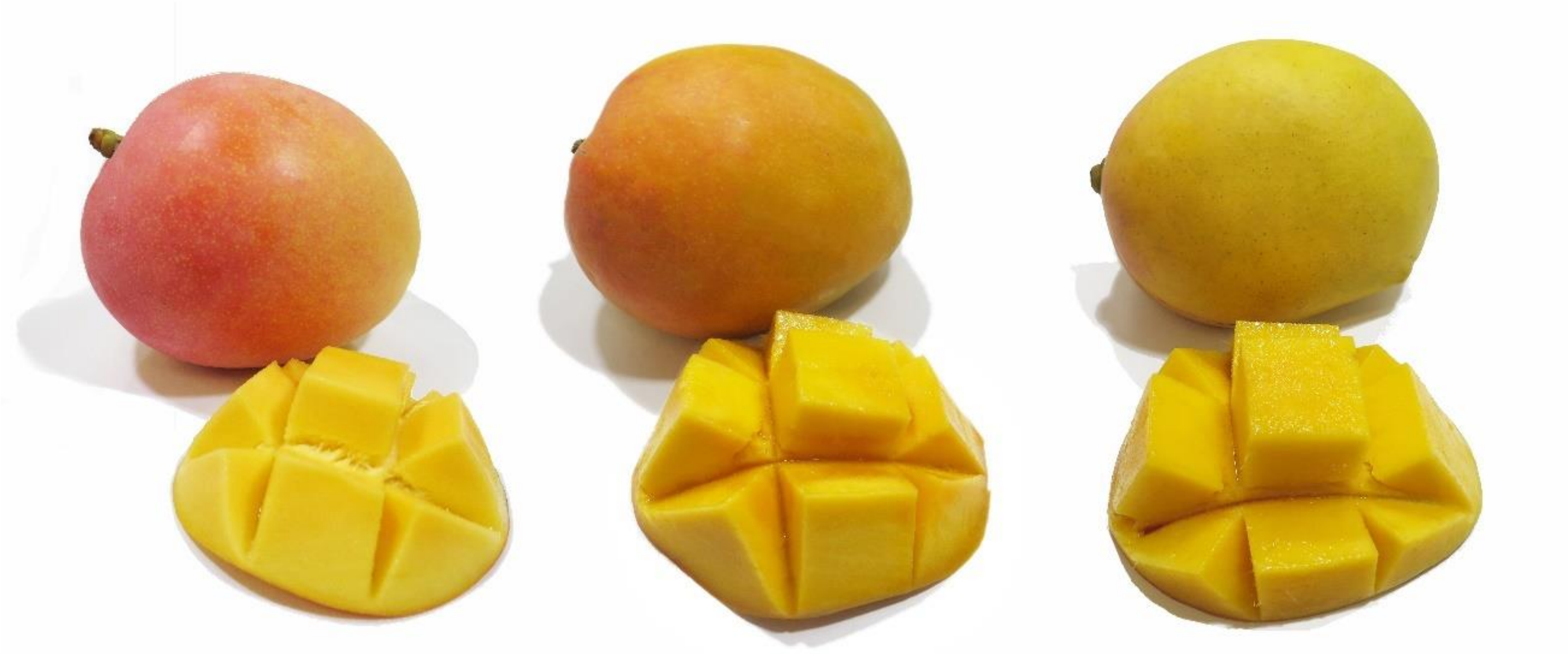
Introducing the problem.



QUT

NORTHERN TERRITORY GOVERNMENT

The Australian mango industry



Photos: left: Calypso, middle: Honey Gold, right: KP

Problem 1:

production pests and diseases

- In Australia the major mango diseases include Anthracnose, Stem End Rot, Dendritic Spot and Alternaria Rot.
- Mango producers currently use a combination of fungicides and insecticides, which is increasingly affecting market access.

Sources: Chin et al., 2010; Johnson, 2008; Hejazi et al., 2022

Problem 1:

production pests and diseases

The APVMA has reviewed a number of chemicals for use in tropical exotic fruit over the past 15 years:

- Benomyl -deregistered in 2006
- Fenthion -deregistered in 2014
- Dimethoate -deregistered for post-harvest use in 2023
- Fipronil -currently under review
- Neonicotinoids -currently under review

Sources: APVMA, 2023

Problem 2:

water stress in a changing climate

- Meteorological data for the NT reveals a warming trend.
- In Darwin, 327 days per year exceed 30°C.
- Modelling suggests that the frequency of particularly hot days will continue to rise.
- Rising temperatures and erratic rainfall, will affect basic plant physiology:
    - increased evapotranspiration,
    - increased periods of plant water stress.

Sources: Hoegh-Guldberg et al., 2018; Sheldon, 2019; BOM et al., 2019; Clonan et al., 2020; Chen et al., 2023; Zheng et al., 2022

Problem 2:

water stress in a changing climate

- Mangoes experience seasonal variation in net photosynthesis rate and stomatal conductance.
- In northern Australia this is accentuated during “dry season” period from May to December.
- Multi-cultivar trials have established that KP has low photosynthetic accumulation during this period, even after irrigation and does not maintain photosynthesis during environmental stress.

Sources: Carr, 2013; Chisholm et al., 2006; Damour et al., 2009; Lu, 2013; Lu et al., 2012

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Plant Activators:

- Integrated Pest Management (IPM) option that focuses on boosting the plant defence response.
- Sometimes effective in other crops but not every crop or every stress.
- Examples include: Salicylic Acid (SA), Jasmonic Acid (JA), and Abscisic Acid (ABA), Phosphite etc.

MAYBE?

MAYBE NOT?

Sources: Takushi et al., 2014; Yang et al., 2019, Iqbal et al., 2021; Miura and Tada, 2014; Seleiman et al., 2021; Akem et al., 2013 ; Araujo et al., 2015; Zeng et al., 2006; Hmmam et al., 2022; Dann, 2011; Machinandiarena et al., 2012; Nascimento et al., 2016

The project

Challenge plants

- Biotic (pest and disease)
- Abiotic (water deficit)
- Plant activators

Determine changes in gene expression

- Sequence RNA
- Differential expression analysis

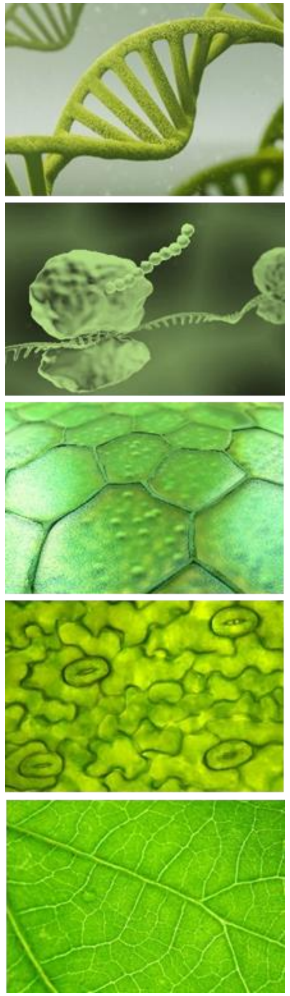
Measure physiological reactions

- Photosynthesis
- Biomass
- Lesion size

Outcomes

- Genetic model for mango plant defence.
- Comparisons between varieties.
- Determine effectiveness of PA's.

Plant defence systems



Genetic

DNA & RNA (up-regulation/ down-regulation)

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Biochemical

Proteins (enzymes/ hormones etc.)

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Physiological

Reduced photosynthesis, closed stomata etc.

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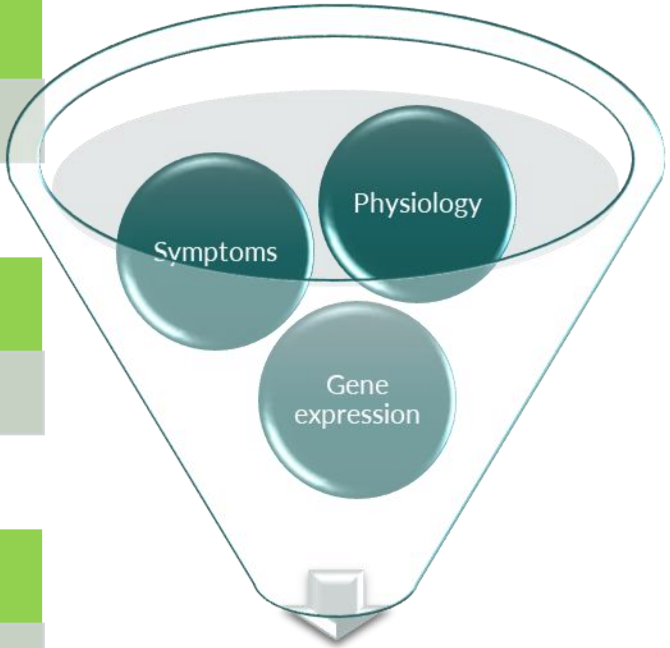
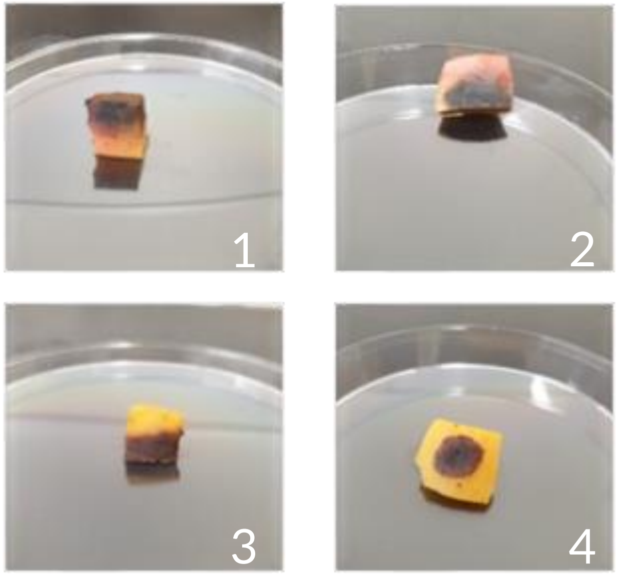
Physical symptoms

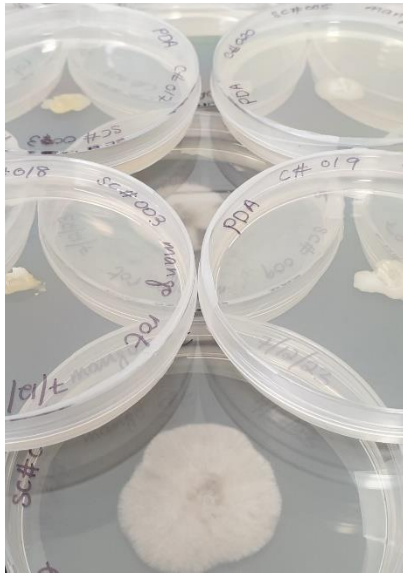
Lesions, yellow leaves, stunted growth etc.

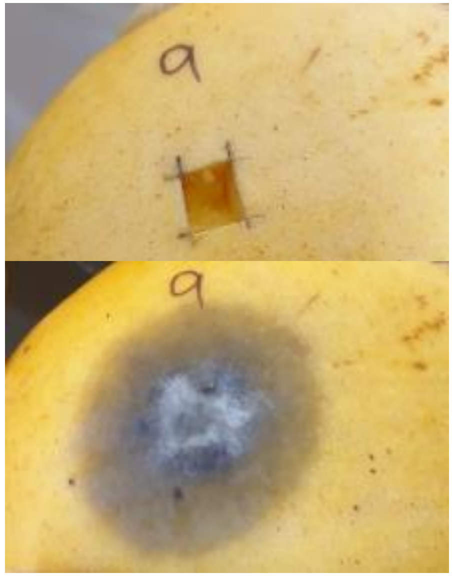


Mango model

The project: groundwork







The project: next steps

- When the plants are advanced enough (3-6 months of root development), apply treatments.
- Measure the physiological response.
- Sample the plants, extract & sequence the RNA.
- Analyse sequencing data using bio-informatics.
- Correlate what is happening at the genetic level with what we are seeing/ not seeing on the plants.

The project: outputs

- Scientific journal article(s).
- Grower information on variety differences.
- Grower information on PAs.

Acknowledgements

This project is a collaborative project between QUT and NT DITT.

Supervisory team:

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- Dr. Brett Williams (QUT)
- Dr. Anthony James (QUT)
- Dr. Upendra Shekhawat (NT DITT)

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