Peanut Kernel Shrivel (PKS) – An Undiagnosed Condition of Peanut Crops in Queensland, Australia

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Department of Agriculture, Fisheries and Forestry

UNIVERSITY OF SOUTHERN QUEENSLAND AUSTRALIA

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Outline

- What is PKS (symptoms)?
- Where does PKS occur?
- When did PKS occur (time course)?
- What are economic impacts (for growers and industry)?
- What R&D has been conducted on PKS
- What is most likely cause of PKS?
- Future R&D and potential solutions to PKS?

What is PKS (symptoms)?

PKS occurs in crops with normal/healthy canopy growth

What is PKS (symptoms)?

Protruding testa veins

Reduced kernel size

Kernel abortion

Discoloured (tan) testa

Swollen funiculus

Sprouting

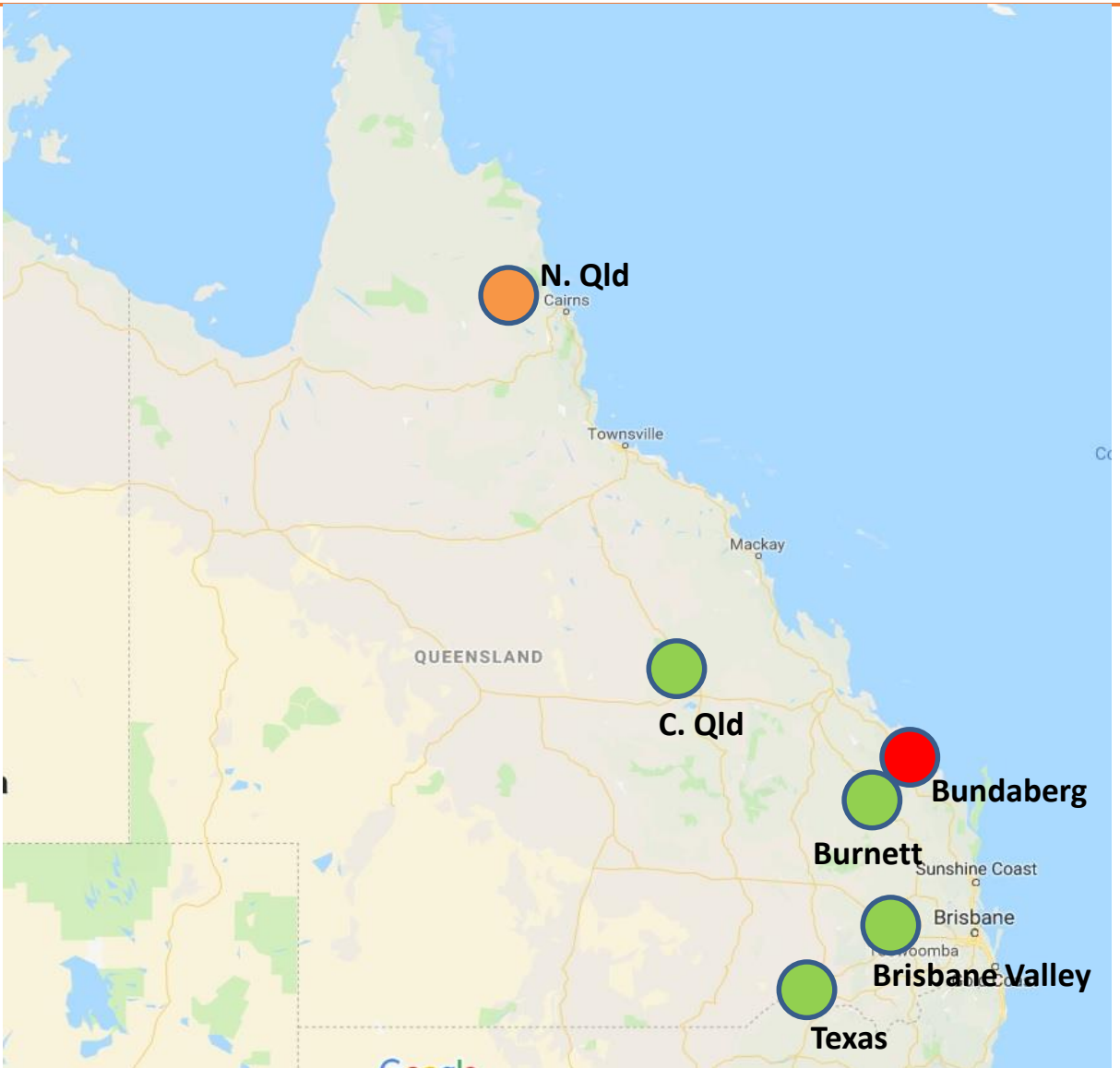
What is PKS (symptoms)?

Despite reduced size, kernels are otherwise normal:

- **Taste/flavour ok**
- **Germination ok**
- **Blanchability ok**

PKS appears to affect normal assimilate transport through funiculus/testa, to reduce kernel size

Where does PKS occur?



We have observed varying levels of PKS in all production regions (N and S Qld), however it is most severe in Bundaberg, S Qld

- Severe PKS observed
- Mild PKS observed
- Very low PKS incidence

Where does PKS occur?

Normal kernels
S Burnett/Kingaroy

Normal kernels
Brisbane Valley

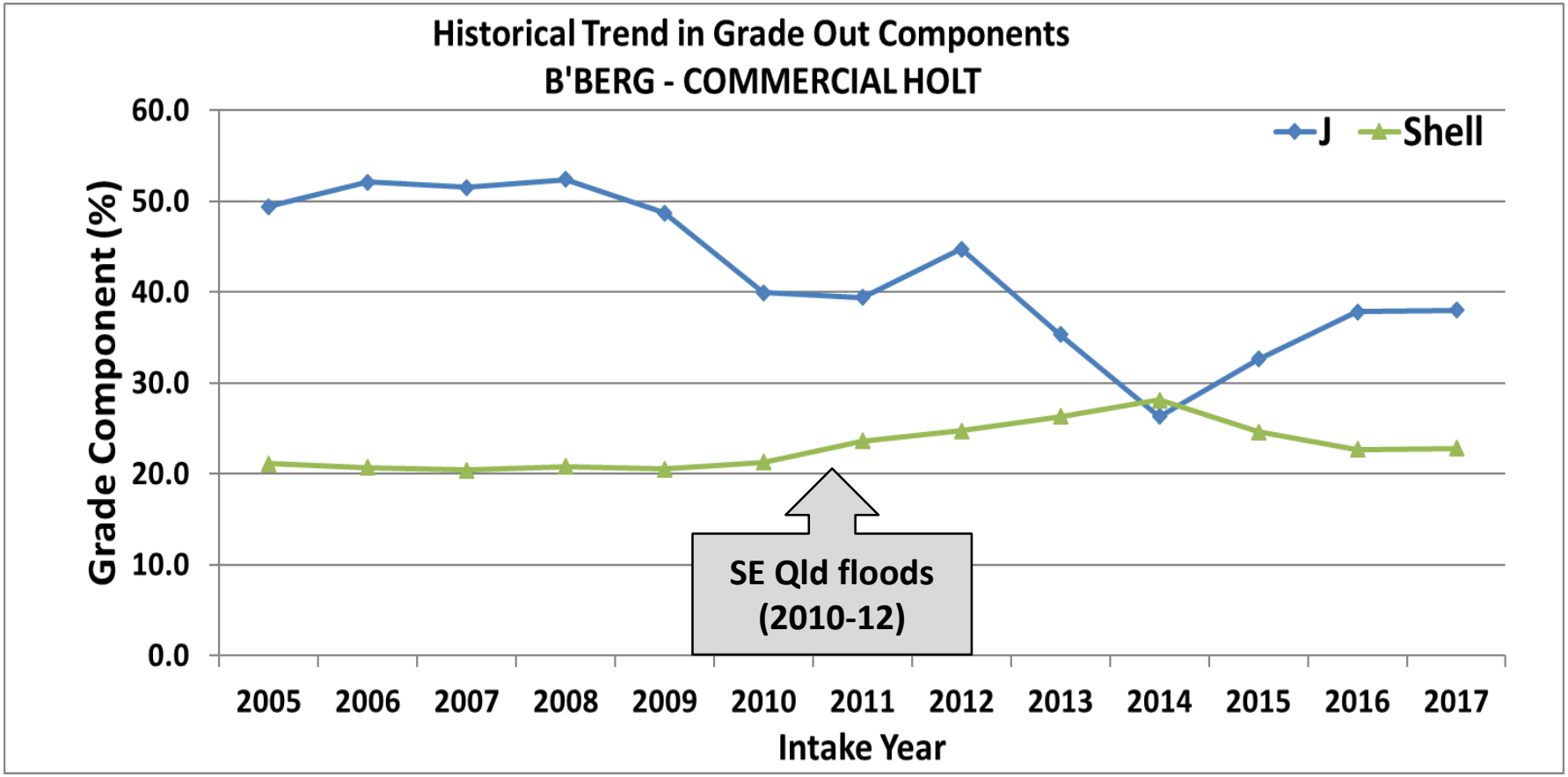
PKS affected kernels
Bundaberg

When did PKS first occur (time course)?

Grade components are very good surrogate measures of PKS

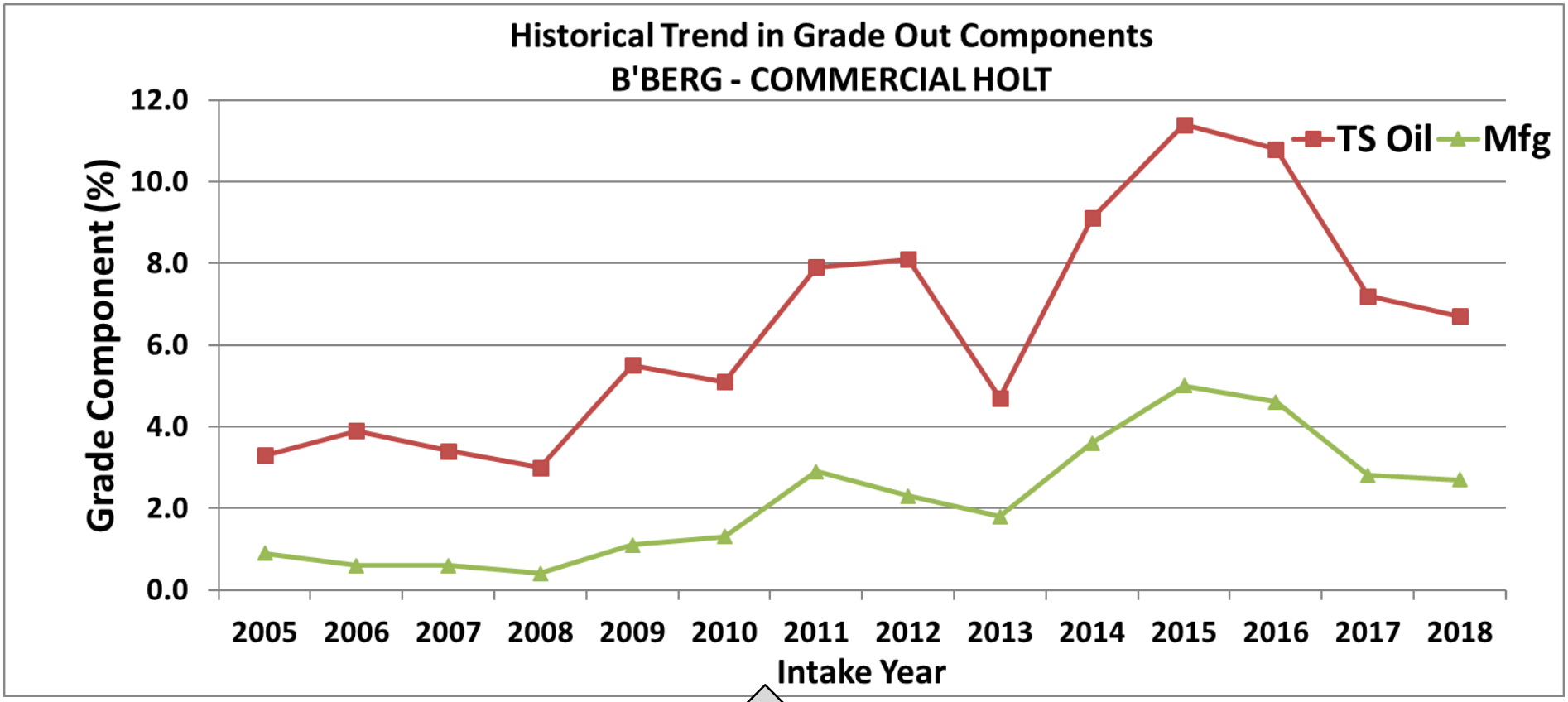
(Commercial intake date – 5 - 10,000Mt/year)

Since 2010, Jumbo % ↓ and Shelling % ↑, with some recovery after 2014



When did PKS occur (time course)?

Since 2010, Through Sieve Oil % and Manufacturing % have both ↑ with some recovery after 2014



SE Qld floods (2010-12)

What are economic impacts?

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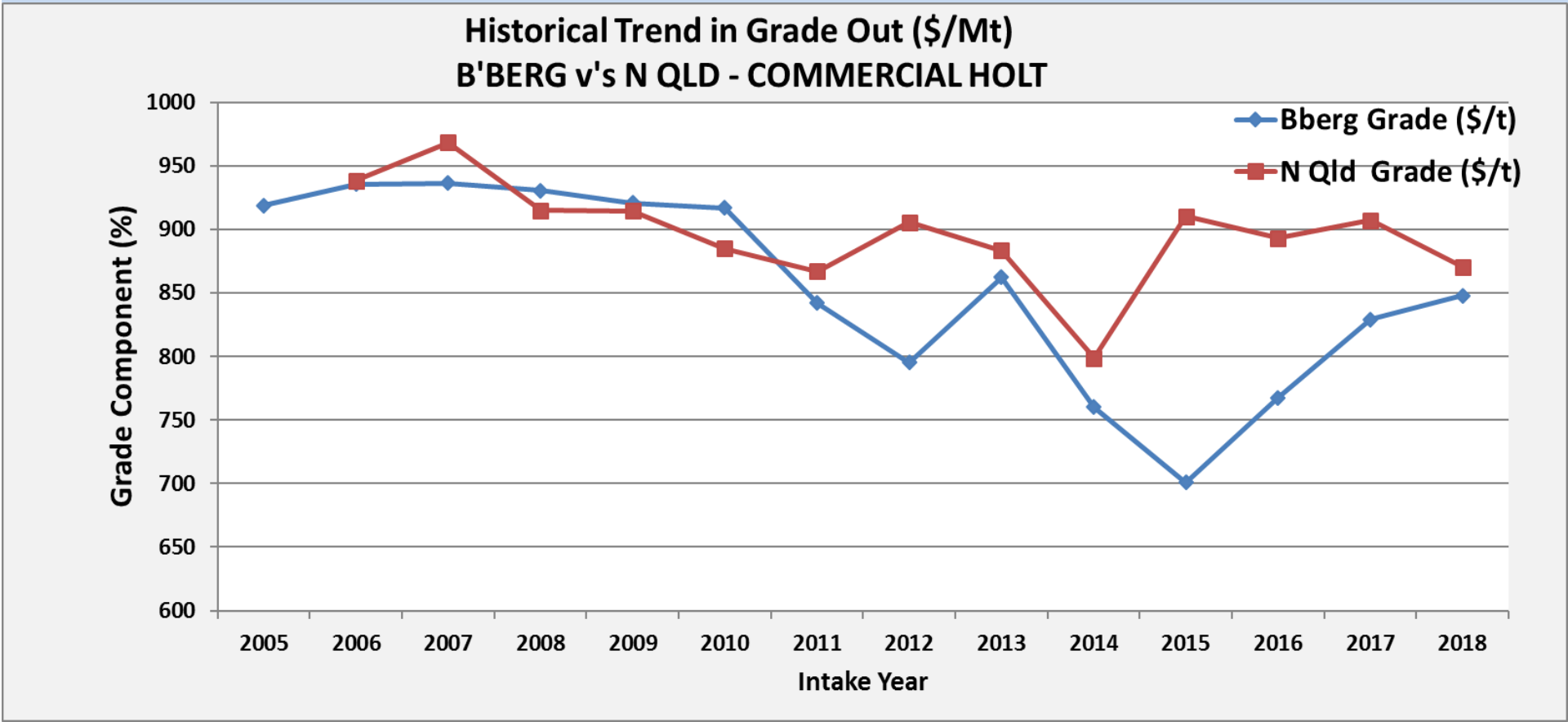
**** PKS has reduced peanut quality (i.e. Grade Price in $/Mt) ranging from ~ $50 - $200/Mt during period 2011 – 2018, and Pod Yields reduced by ~ 5-10%***

**** Grower impacts of ~$500-$1450/ha***

**** Industry impact of ~ $0.2 - $1.6M p.a., and a total loss of ~$5.5M over past 9 years***



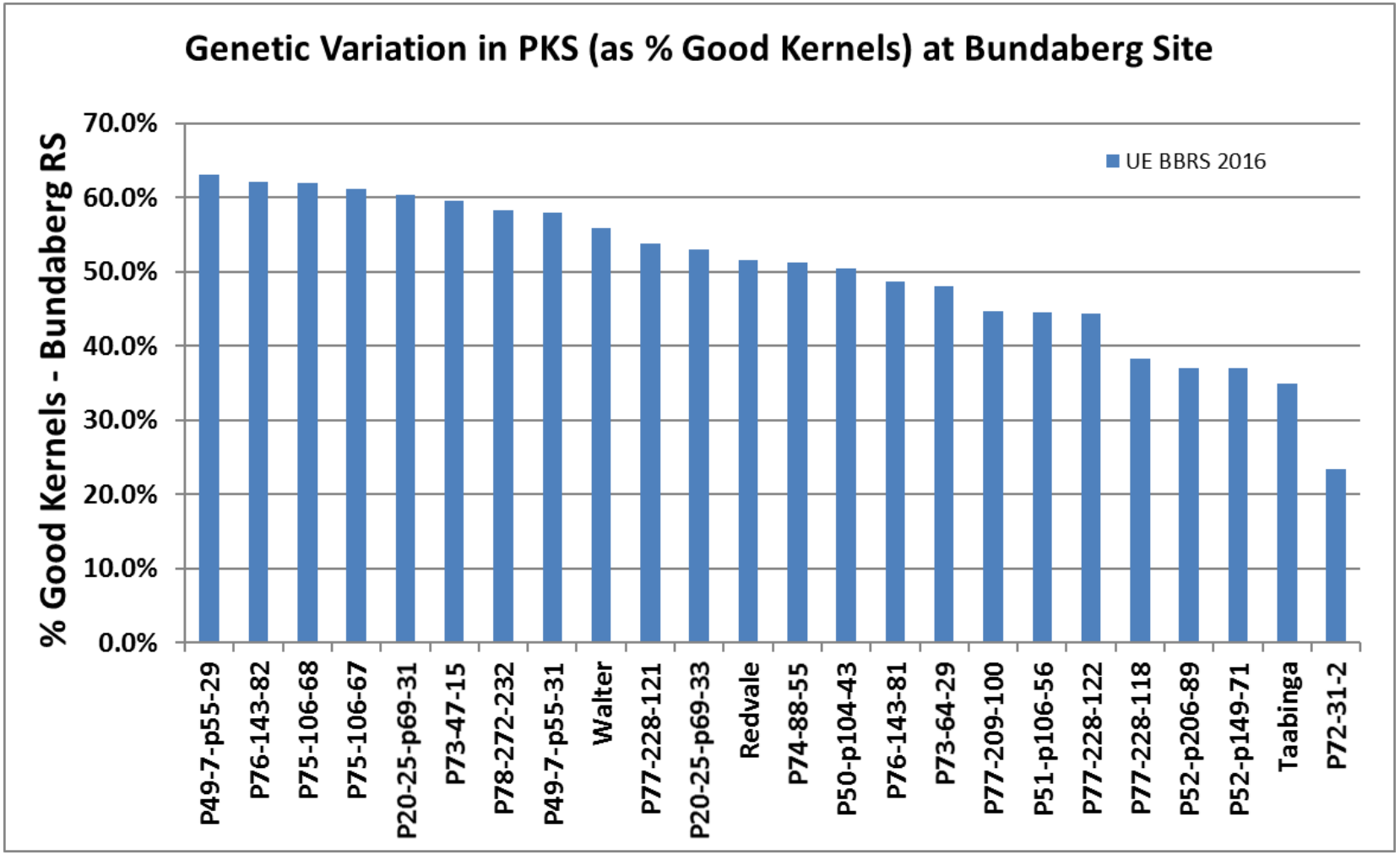
What R&D has been conducted on PKS

- Since 2014, a major R&D effort to determine cause of PKS, involving agronomists, pathologists, virologists, entomologists, physiologists
- No real leads until very recently ….

Potential Cause		Findings
Water Quality/Source		No evidence
Soil Nutrition (esp Ca & B)		All nutrient levels within normal ranges
Viruses		No **known** or new viruses identified
Fungal/bacterial pathogens		No **known** or new bacteria identified. Possible peg lesions and enhanced levels of *Fusarium oxysporum* in roots/stems
Seed Transmission/Source		PKS affected loads not linked to a **specific** seed source
Insects		No **known** or new insect pests identified
Variety/Genetics		Very large genotypic variation in PKS susceptibility/tolerance observed in our Variety Trials

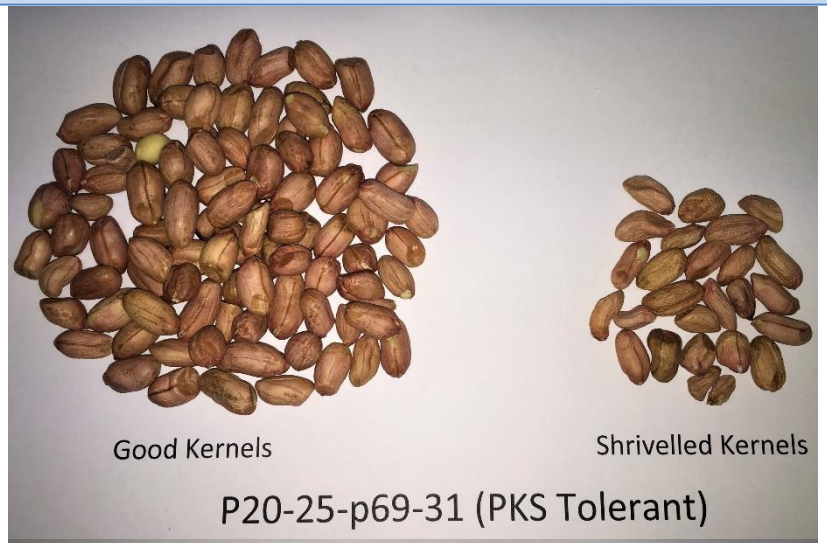
What R&D has been conducted on PKS

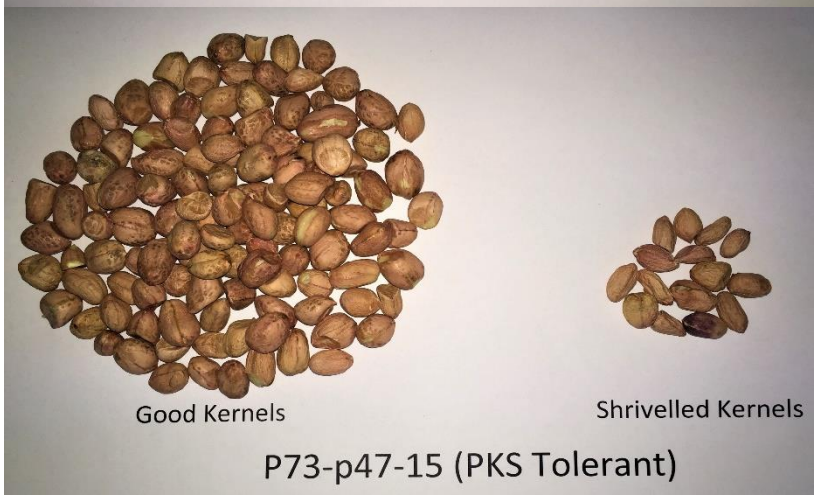
Good Evidence for Genetic Variation in PKS Tolerance



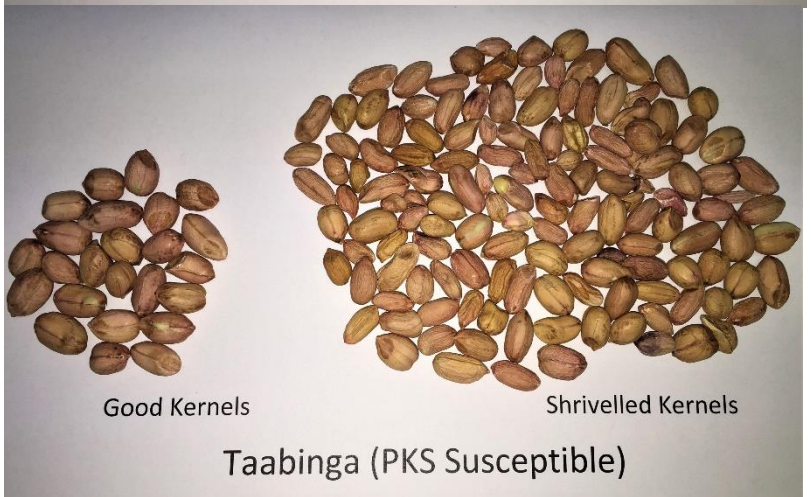
What R&D has been conducted on PKS

Examples of PKS Tolerant Lines



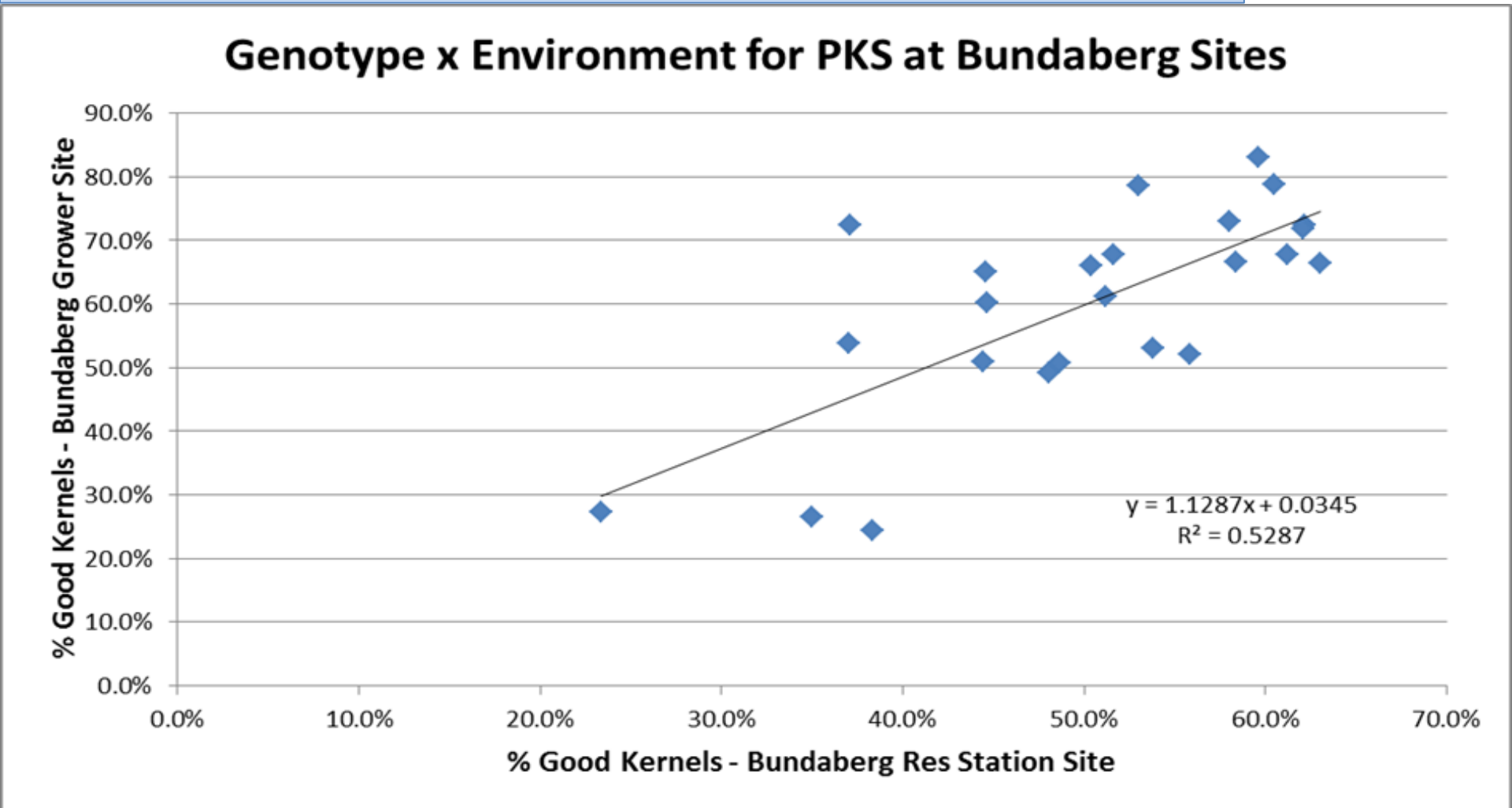


Examples of PKS Susceptible Lines



What R&D has been conducted on PKS

Preliminary data also suggests there is low GxE for PKS Tolerance and hence may be under strong genetic control



What is most likely cause of PKS?

Very recent data suggests PKS is associated with a PHYTOPLASMA, vectored by the Australian "Brown Leaf Hopper"

- From 2017 and 2018 peanut crops, QDAF Virologist, Dr Murray Sharman, has found strong evidence for a link between Phytoplasma and PKS. He noticed a higher than normal incidence of "Little Leaf" symptom in peanut crops (known to be caused by Phytoplasma), and found PKS affected kernels were associated with these Phytoplasma infected plants

Phytoplasma testing for peanuts from Bundaberg, collected in Feb 2018

- **Non-symptomatic plants** 10 plants with no symptoms on foliage or pods were tested in bulks, all were negative for phytoplasma by PCR.

Typical pods and kernels from a non-symptomatic (healthy) peanut. Not quite fully mature

Phytoplasma testing for peanuts from Bundaberg, collected in Feb 2018

- **Phytoplasma symptomatic plants** 16 out of 16 plants were positive by PCR. All plants appeared to have some or many PKS-like pods (see images below)

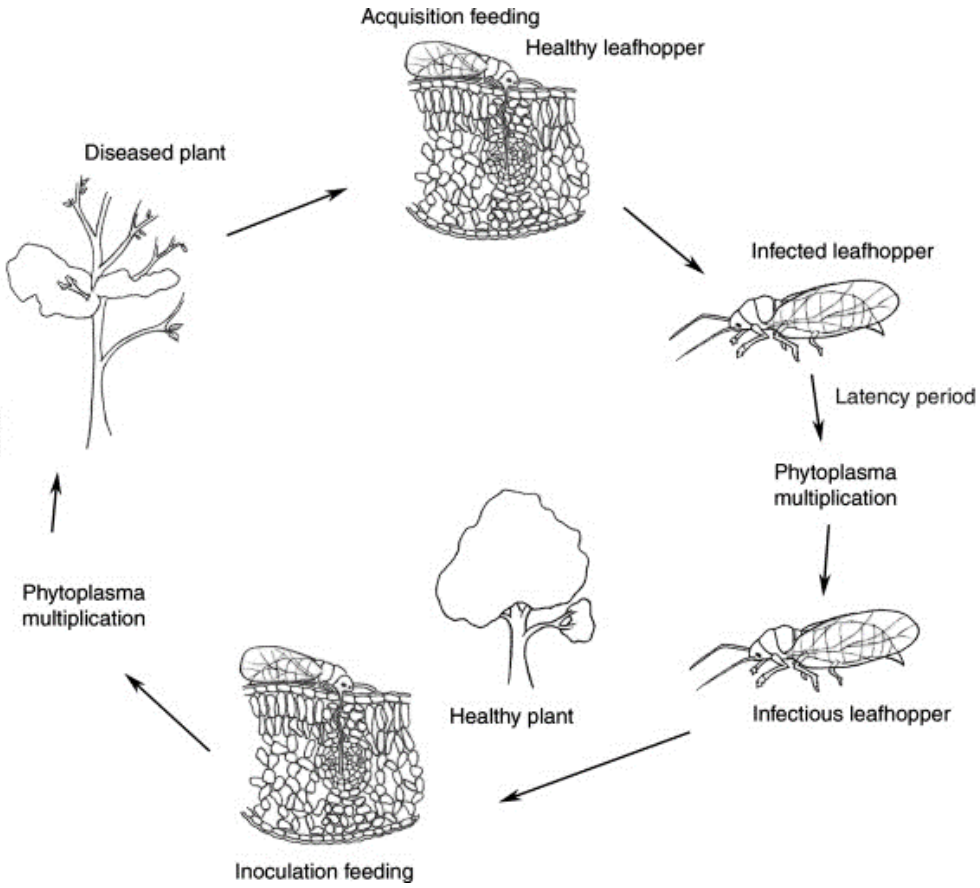

ID: 20180303ms-1, positive, (photo


ID: 20180301ms-33, positive, (photo


ID: 20180301ms-32, positive, (photo 3946), one branch only with phyto symptoms


ID: 20180301ms-2, positive, (photo 3941), late infection

Phytoplasma – Brown Leaf Hopper Lifecycle



Definition

Phytoplasmas are obligate bacterial parasites of plant phloem tissue and of the insect vectors that are involved in their plant-to-plant transmission. Phytoplasmas were discovered in 1967 by Japanese scientists who termed them mycoplasma-like organisms (MLOs)

The **common brown leafhopper**, *Orosius orientalis* has a very wide host range, and vectors several viruses and phytoplasmas worldwide causing a range of economically important diseases in a range of crops

Source: https://wikivisually.com/wiki/Common_brown_leafhopper

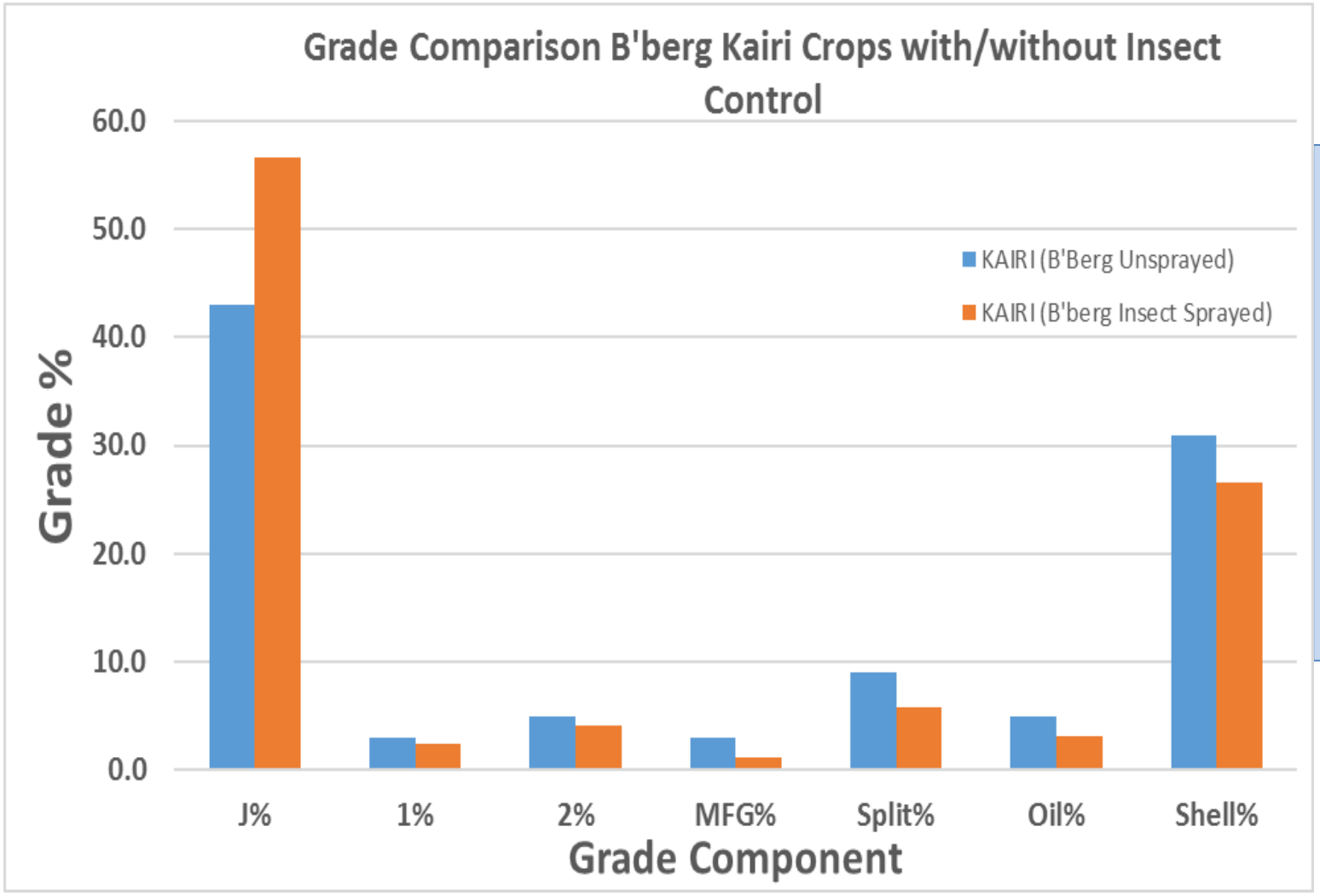
Increased Phytoplasma Incidence observed in Other Crops in Australia since 2011

Seed shrivel in Chickepa

Flower/pod abortion in soybean

Little leaf/puffy pod in Mungbean

Preliminary Insect Control Results from Bundaberg Peanut Crops during 2017/18 (Neil Halpin and Bill Rehbein)



Insect controlled peanut crops tended to have better grade out, suggesting possible control of Brown Leaf Hopper/ Phytoplasma/ PKS

Future R&D and potential solutions to PKS?

- **Conduct Koch's postulate to prove Phytoplasma hypothesis**
- **Conduct insect management trials to control Brown Leaf Hopper populations in peanut crops**
  - **Can a strategic insecticide program control Brown Leaf Hoppers?**
  - **See previous slide for preliminary results with insect controlled crop in 2017/18**
- **Confirm genotypic tolerance to PKS, and progress potential release of PKS tolerant varieties?**

Acknowledgements

- **Neil Halpin** (Senior Agronomist) Queensland Department of Agriculture and Fisheries
  - GRDC Coastal Hinterland Growers Solutions Project
- **Mr Dan O'Connor** (Seed Agronomist) Peanut Company of Australia
- **Peter Hatfield** (Peanut Consultant) Arachis Australia
- **Prof. Michael Bell** (Chair in Tropical Agronomy) The University of Queensland
- **Dr Murray Sharman** (Virologist) Queensland Department of Agriculture and Fisheries
- **Prof. Graham Farquhar and Dr Hilary Stuart-Williams** (Research Officer) Australian National University
- **Dr Rosemary White** (Plant Physiologist) CSIRO
- **Sue Thompson** (Plant Pathologist) Centre for Crop Health, University of Southern Queensland
- **Dr Anthony Young** (Bacteriologist) Centre for Crop Health, University of Southern Queensland