Grain storage in northern Australia: Pest and resistance diagnostics and its implications for industry

Dr Raj Jagadeesan

Senior Research Scientist (Entomology)

Postharvest Commodity Protection

Department of Agriculture and Fisheries (DAF),
Queensland 4102

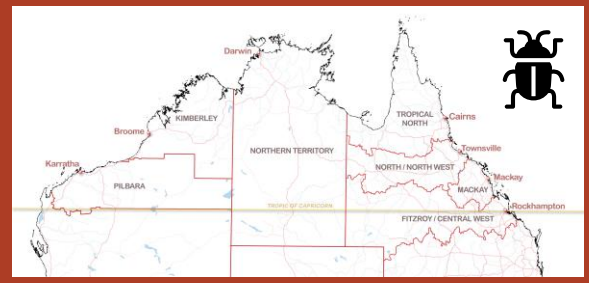
Queensland Government

What's new in northern Australia?

- **Broad acre cropping expands**
  - Maize, Sorghum, Mung beans, and Soybean

- **On-farm storage is gaining momentum**
  - Promoting regional grain value chain (partial functioning of TSV port)

- **Tropical humid climate and lack of data**
  - constitutes an impediment to long-term investments



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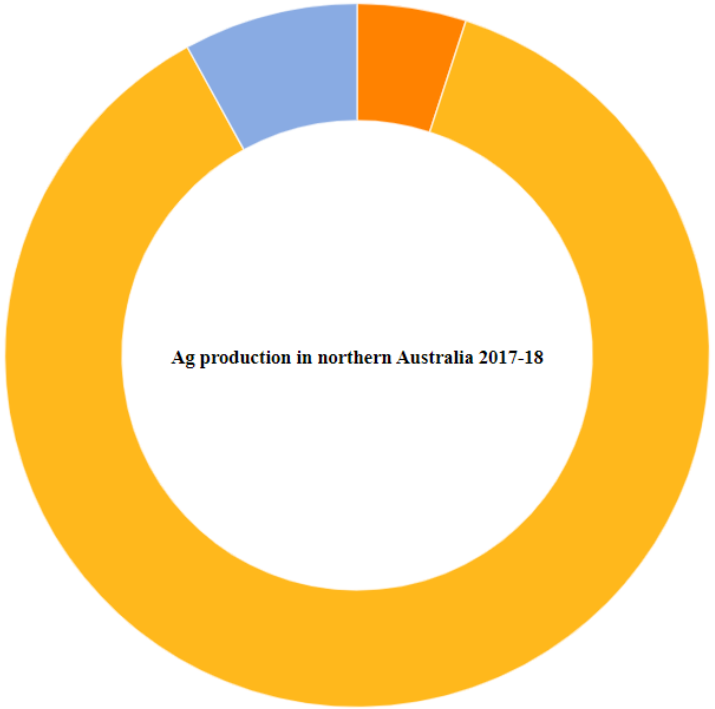
ensland dominates agricultural production across the three jurisdictions tha
hern Australia, with Western Australia accounting for the least.



rch Centre for Developing Northern Australi

Queensland dominates in Ag Investments

- Crop diversification
- On farm storage structures
- Maximising grain supply chain efficiency

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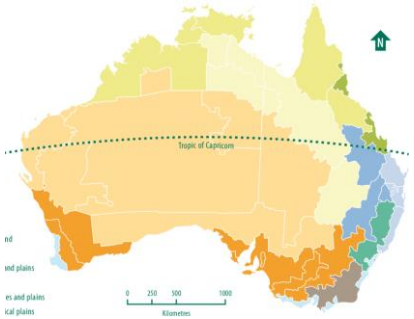
Cooperative Research Centre for the Development of Northern Australia (CRCNA)

"Integrated management to ensure market access for northern Australian grain"

- Establishing **pest and resistance** profiles (QLD, NT and WA)
- Identifying suitable **chemical and non-chemical control strategies** for farms
- **Outreaching key findings** of the project to the industry for adoption



Grain sampling survey

- **>100-grain samples** collected over northern Australia over **30 storage sites**
  - **Northern QLD**: 18 storage sites (Townsville and MacKay)
    - Two major seasons (Feb-May; Sep-Dec)
  - **Northern Territory**: 6 sites (Daly and Arnhem)
    - July-Aug
  - **Northern Western Australia**: 6 sites (Broome and Kununurra)
    - July-Aug
- **100 field insect populations** of multiple insect species are maintained in the laboratory

Key stored grain insect pests

Red flour beetle (RFB)

Lesser grain borer (LGB)

Rice Weevil (RW)

Maize Weevil (MW)

Rusty Grain Beetle (RGB)

Saw-toothed Grain Beetle (SGB)

Bruchids (BDS)

Booklice (BL)

Pest profile

Northern Queensland

- **98.5 % of grain samples** infested and contained >2 live insect pests
- Red Flour Beetle (RFB) > Rusty Grain Beetle (RGB) > Rice Weevil (RW)
- Maize Weevil (MW), Bruchids (BDS), and Lesser Grain Borer (LGB)

Northern Territory

- RFB, LGB and RGB
- BDS

Northern Western Australia

- RFB infestation was found in all the grain samples
- RFB > RGB> Saw-toothed Grain Beetles (SGB)

Resistance profiling

- **Susceptibility to fumigant, Phosphine (PH_3)**
  - Northern Queensland**: 26 insect populations –** strongly resistant
    - 16 RFB; 8 RGB, 1 RW, and 1 LGB
  - Northern Western Australia and Northern Territory**:** 8-9 strongly resistant RFBs

- **Susceptibility to grain protectant** (conserve on-farm): Spinosad 120g/L + Chlorpyriphos-methyl 500g/L + S-methoprene 30g/L
  - No tolerance/ resistance reported in any of the five species tested

- **Susceptibility to Diatomaceous Earth (DE)**
  - All RFBs showed considerable levels of resistance to DE.

Percent resistance to fumigant, phosphine in key grain insect pests collected from Townsville




Insect species	Number of populations tested	Phenotype diagnosed			Weak Resistance (%) (Range[3])	Strong Resistance (%) (Range[3])
		Susceptible	Weakly resistant[1]	Strongly Resistant[2]		
LGB	5	0	4	1	53-99	59
RFB	29	0	13	16	1-88	1-58
RGB	11	0	3	8	51-100	1-74
RW	8	0	7	1	1-84	0-1
MW	1	0	1	0	75	0

Lesser Grain Borer (**LGB)**, *Rhyzopertha dominica*, Red Flour Beetle (**RFB**), *Tribolium castaneum*, Rusty Grain Beetle (**RGB**), *Cryptolestes ferrugineus* Rice Weevil (**RW**), *Sitophilus oryzae*

[1]Insects were exposed to phosphine at 0.03 mg l^{-1} over 20 hrs; [2] Insects were exposed to phosphine at 0.25 mg l^{-1} over 20 and 48 hrs exposure periods for RFB, and LGB, respectively. For RGB, test insects have been exposed to 1mg l^{-1} over 168 hrs.; [3]Values within the parenthesis represent minimum and maximum percent resistance values recorded among the multiple populations tested

Effectiveness of grain protectant, Conserve On-farm (Spinosad 120 g/L + Chlorpyriphos-methyl 500 g/L + s Methoprene 30 g/L) at 35°C and 70% RH.

Region	Pest species tested*	Mortality	
		Adults[1]	Progeny[2]
nQLD	LGB	100	100
	RFB	100	100
	RGB	100	100
	RW	100	100
	MW	100	100
NT	LGB	100	100
	RFB	100	100
	SGB	100	100
nWA	RFB	100	100
	SGB	100	100

*Reference insect populations established from healthy insect samples collected from multiple storage sites within each state/region

[1]Adult insects two weeks after eclosion were challenged with treated grain and maintained at high temperature (35°C) and humidity (75%) mortality was recorded after 14 days

[2] Effectiveness against immature life stages, eggs, larvae, pupae of parental adults (F_1) estimated in comparison to the number of freshly emerged adults in untreated control

Effectiveness of Diatomaceous Earth (DE) in concretes at 35°C and 75% RH

Region	Pest species tested*	Mortality[1]
nQLD	LGB	100
	RFB	54.7 % ± 7.5
	RGB	100
	RW	100
	MW	100
NT	LGB	100
	RFB	59.8 % ± 14.2
	SGB	100
nWA	RFB	94.0% ± 3.1
	SGB	100

*Reference insect populations established from healthy insect samples collected from multiple storage sites within each state/region

[1]Adult insects two weeks after eclosion were released into treated concrete surfaces and the set up was placed at high temperature (35°C) and humidity (70%). The mortality in both treated and untreated experiments was recorded after 14 days

Trapping

- **Pheromone/bait trapping: Indirect/ Relative sampling**
  - Supports direct grain sampling study – provides ecological/behavioural clues

  - **6 study sites** were selected representing the Burdekin grain supply chain
    - farms, paddy processing site, feed mills, storage sheds near the port, and, pasture land

Trapping results

- Lindgren funnel traps (pheromone)
- Dome traps (bait mixture)

- Fortnightly trap catches (over 2 months) recorded for the period until Dec 2022
  - Pheromone traps – **6135**
  - Baited dome traps – **175**
  - LGB and RFB are the two most common pest species

- Results from 12 months of trapping
  - **“Ecology and Behaviour”** of grain pests in this region

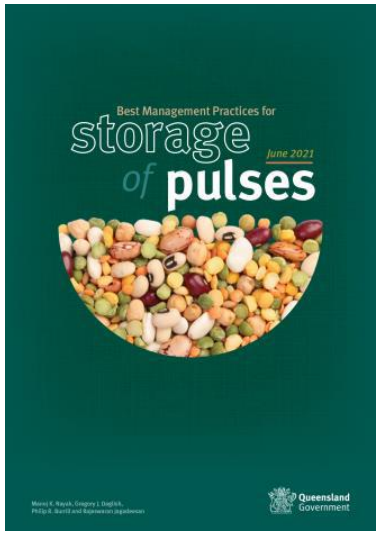
Pest species composition and seasonal abundance

(a) Pheromone-baited Dome traps					
Months	LGB	RFB	RW	RGB	MGB
Oct-22	2	36	7	0	3
Nov-22	29	80	17	0	1
(b) Pheromone-baited Lindgren funnel traps					
Months	LGB	RFB	RW	RGB	MGB
Oct-22	2315	259	33	70	1
Nov-22	1659	161	43	193	0
(c) Unbaited Lindgren funnel traps					
Months	LGB	RFB	RW	RGB	MGB
Oct-22	32	13	3	4	1
Nov-22	29	21	7	12	0

- Dome Vs Lindgren
- Differential species composition in alignment with grain sampling
  - LGB
  - RFB
  - RW
  - RGB

Delivery and Adoption

- **Linkage** with industry
- Agronomists and private agencies
- Utilizing **extension communication** platforms
  - Project workshops
  - Field days
  - Demonstration trials
- Establish trust and ensure **practice change**



Where are we now?

1. Pest profile varies between each region; however, some similarities exist (RFB, RGB)
2. Phosphine resistance is substantially high in RFB (76.7%) and RGB (18.6%)
3. Conserve on-farm: effective against resistant insect pests at tropical environments
4. Diatomaceous earth can be used selectively as surface treatment (e.g. not for RFBs)
5. Trapping reflects local regional activity within a supply chain: two way movement of pests
6. The second phase of sampling in – QLD, WA and NT: reveal more results

Our research focuses on implementing scientific postharvest pest management practices in farms and other stakeholders and ensure knowledge-based transitioning

...will help achieve storage integrity that ensures farmers can be “price makers’ and not “price takers.”

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Raj.jagadeesan@daf.qld.gov.au
07 3708 8546/ 0401957059