



Current status of insect resistance and Resistance Management Strategy

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Queensland
Government

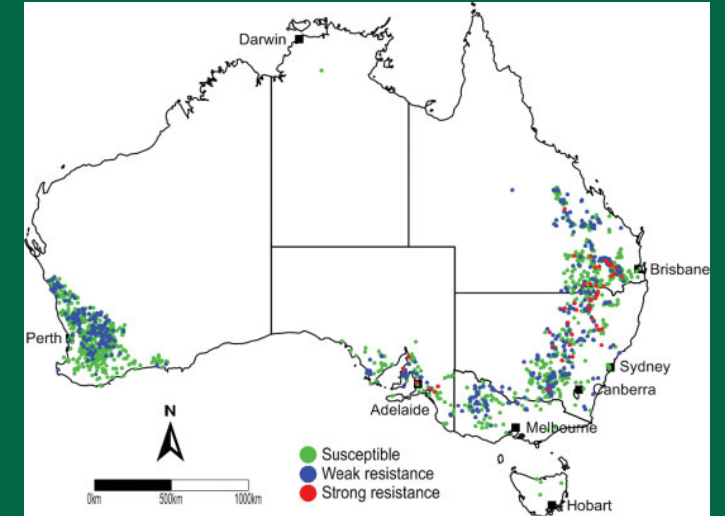
Talk outline

- GRDC National Resistance Monitoring Project (2022-25)
- Resistance Management Strategy
- Trends in phosphine resistance
- Update on sulfuryl fluoride monitoring
- Update on grain protectant monitoring
- Key findings
- Industry interactions
- Ongoing research and future direction



GRDC National Resistance Monitoring Project (2022-25)

- A major GRDC investment, supported by GrainCorp, CBH, Viterra, GrainFlow
- National Team – Brisbane, Wagga Wagga, Perth
- Farms (100) (random survey), BHC samples sent directly
 - Five major species (LGB, RFB, RW, RGB, SGB)
 - Nationally agreed protocol
 - Fumigants (phosphine and sulfuryl fluoride)
 - Grain protectants (spinosad)



GRDC National Resistance Monitoring Project (2022-25)

Other RD&E aspects

- ‘Safe venting period’
- ‘Quick tests’ – phosphine resistance
- Sulfuryl fluoride - resistance-testing protocol for LGB
- ‘Best Management Practices for Phosphine’



Resistance Management Strategy – since 2006

Goal: “Ensure long-term sustainability of grain protection chemicals including fumigants and a range of grain protectants, through strategic adoption and implementation of commercially viable, practical, scientifically-based management strategies”

Objective: “To maintain biological efficacy, cost-effectiveness, and useful life of all grain protection chemicals”

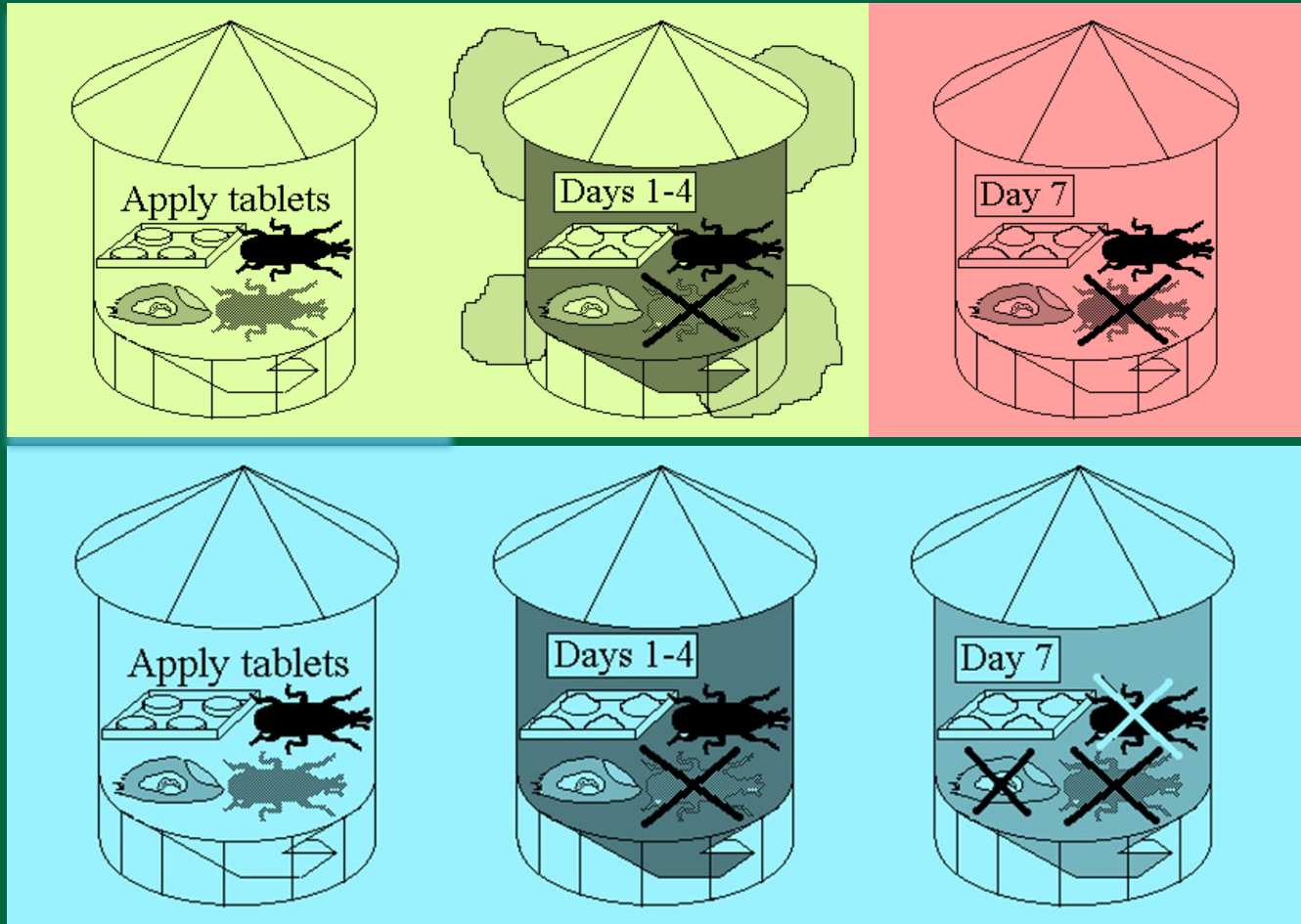
Resistance Management Strategy – core principles

Phosphine

- *Structural integrity* – sealable (AS2628, pressure testing), re-circulation
- *Follow label* – application rates, exposure period, venting
- *Monitor* – gas concentration, pest population (resistance)
- *Destroy resistant populations* – isolate and eradicate, monitor re-infestation
- *Reduce selection* – limit numbers of re-treatment (2-3), hygiene, cooling, non-chemical (DEs, fabric treatments), **rotate with other fumigants (SF)**



Phosphine efficacy - sealed vs unsealed structures



Resistance Management Strategy – core principles

Sulfuryl fluoride (SF)

- *Structural integrity* – sealable (AS2628, pressure testing)
- *Follow label* – application rates, exposure period, venting
- *Avoid short exposure periods* – minimum of 4 days
- *Recirculation* – quick and uniform distribution of gas
- *Monitor* – gas concentration, pest population (resistance)
- *Reduce selection* – **Fumigate once, use as a 'phosphine resistance breaker'**



Resistance Management Strategy – core principles

Grain protectants – long-term protection

- *Ensure market acceptability* - before applying
- *Apply* on freshly harvested grain, never re-apply
- *Follow label* – application rates (proper dilution)
- *Use combined treatments* – (eg. Spinosad + S-methoprene + an OP) - offers blanket control of major spp.
- *Monitor* – pest population (resistance)
- *Rotate with other treatments* – break ‘resistance cycle’
- *Fumigate in case of failure* – Not to re-treat with another protectant



Trends in phosphine resistance (2023-24): Sampling

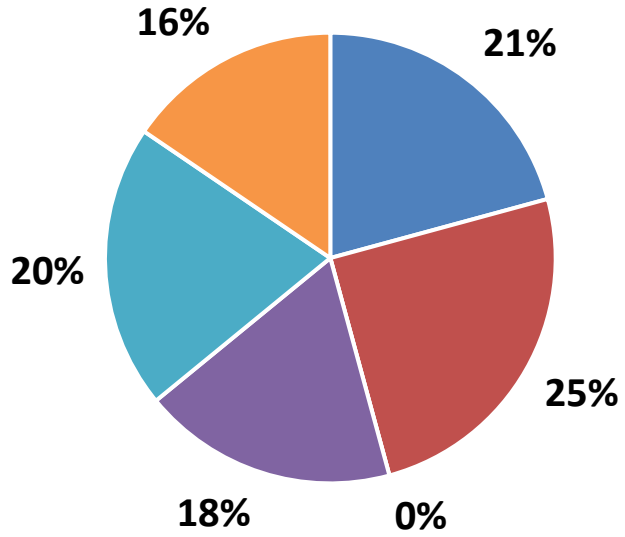
Region	Farm		BHC	
	Sites	Strains	Sites	Strains
Southern	160	284	102	397
Northern	104	248	48	98
Western	110	178	28	99



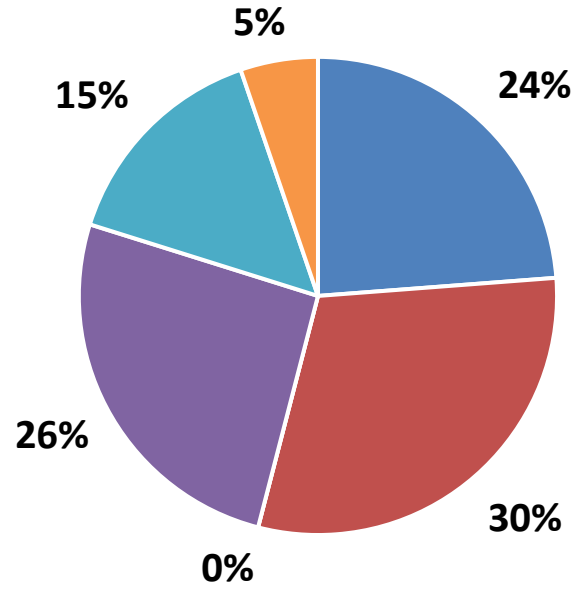
Breakdown of farm strains



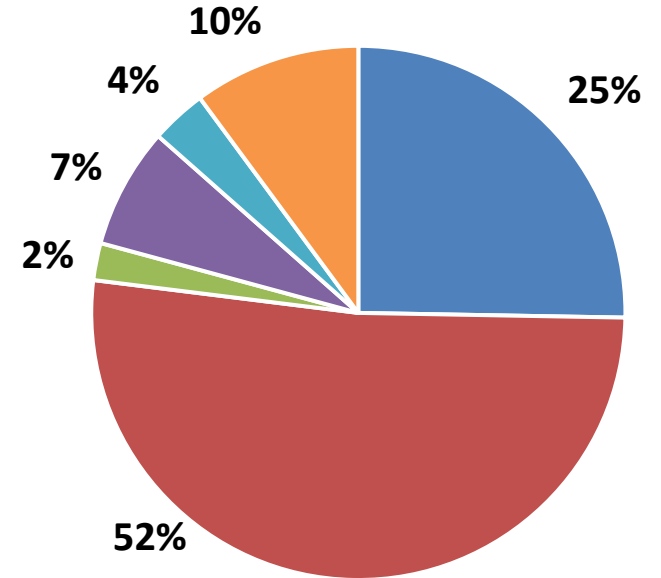
Southern



Northern



Western

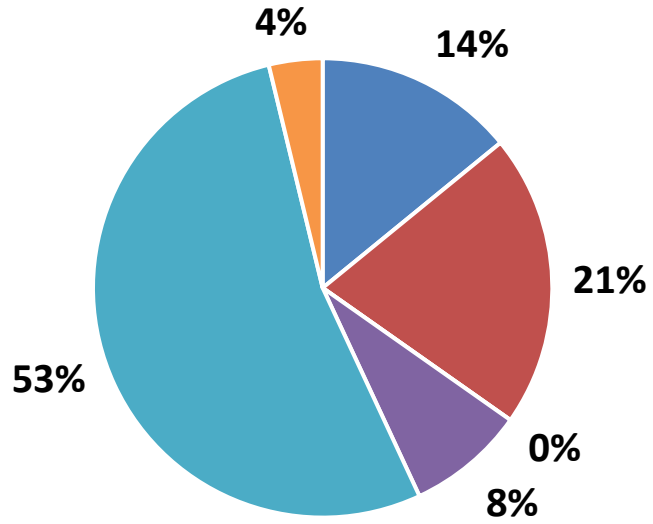


- LGB
- RFB
- CFB
- RW
- RGB
- SGB

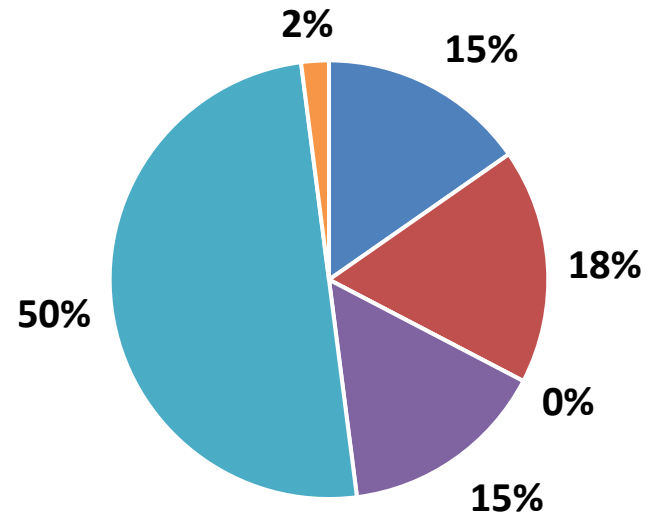
Breakdown of BHC strains



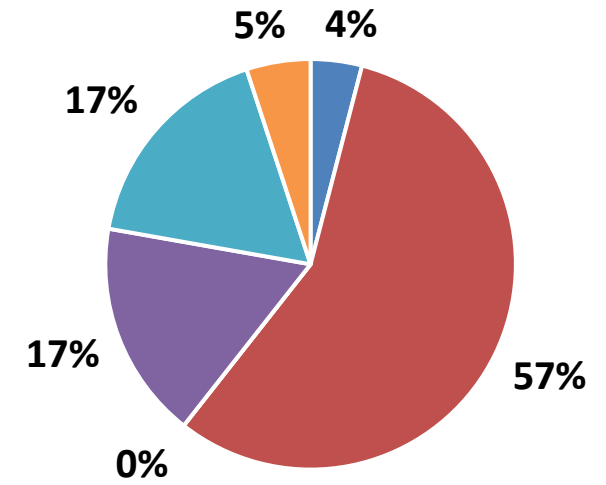
Southern



Northern

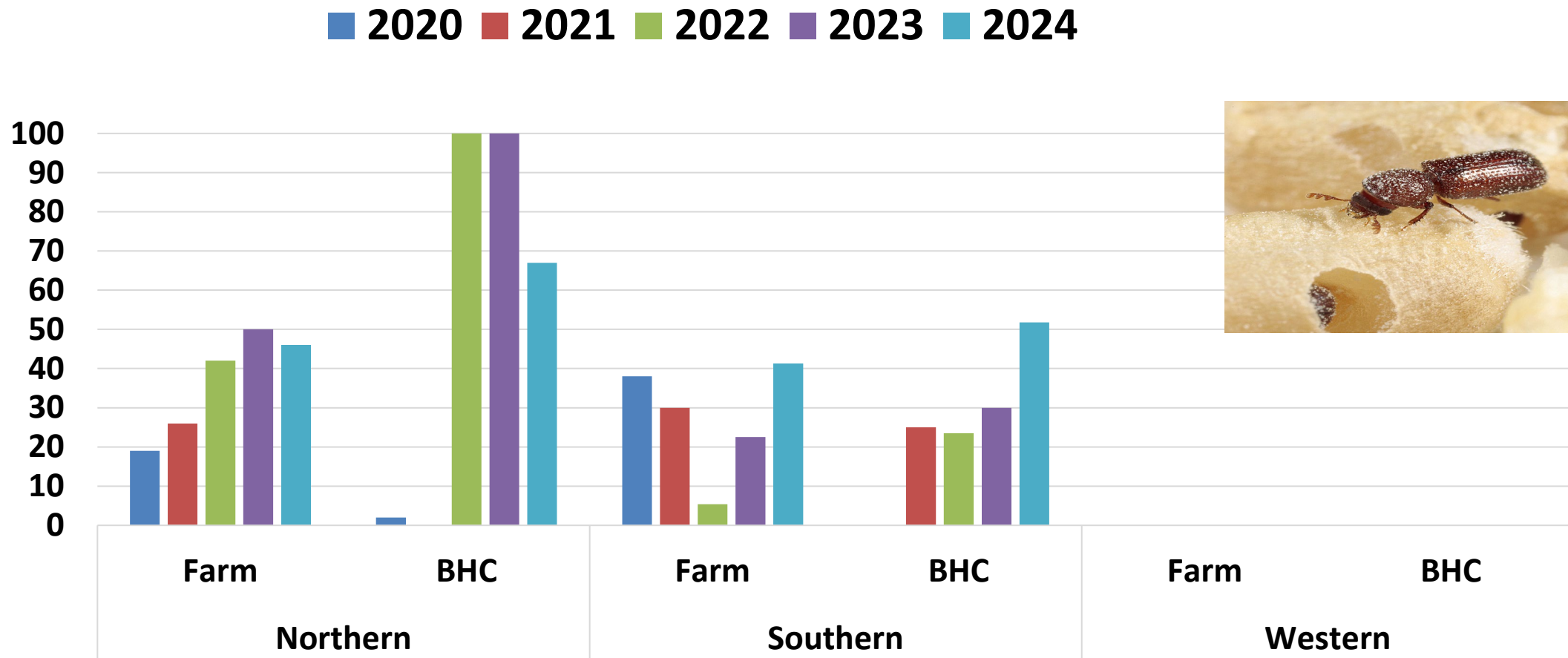


Western

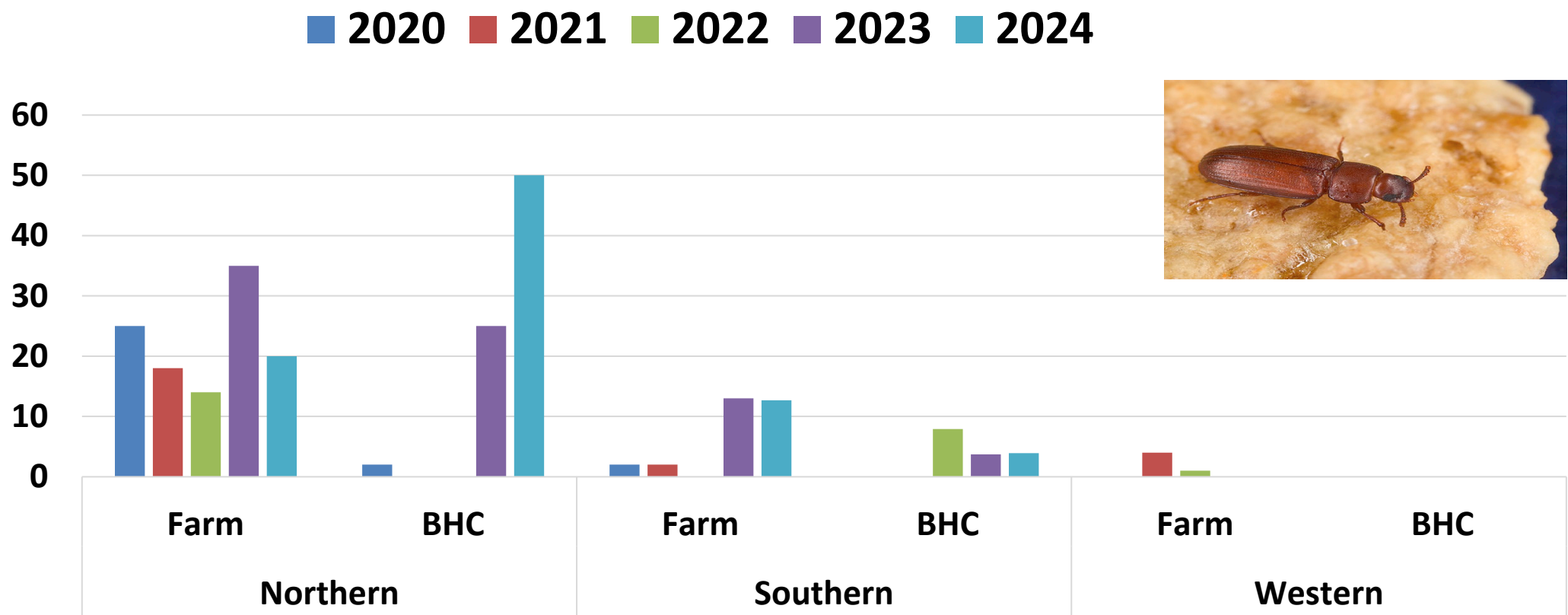


- LGB
- RFB
- CFB
- RW
- RGB
- SGB

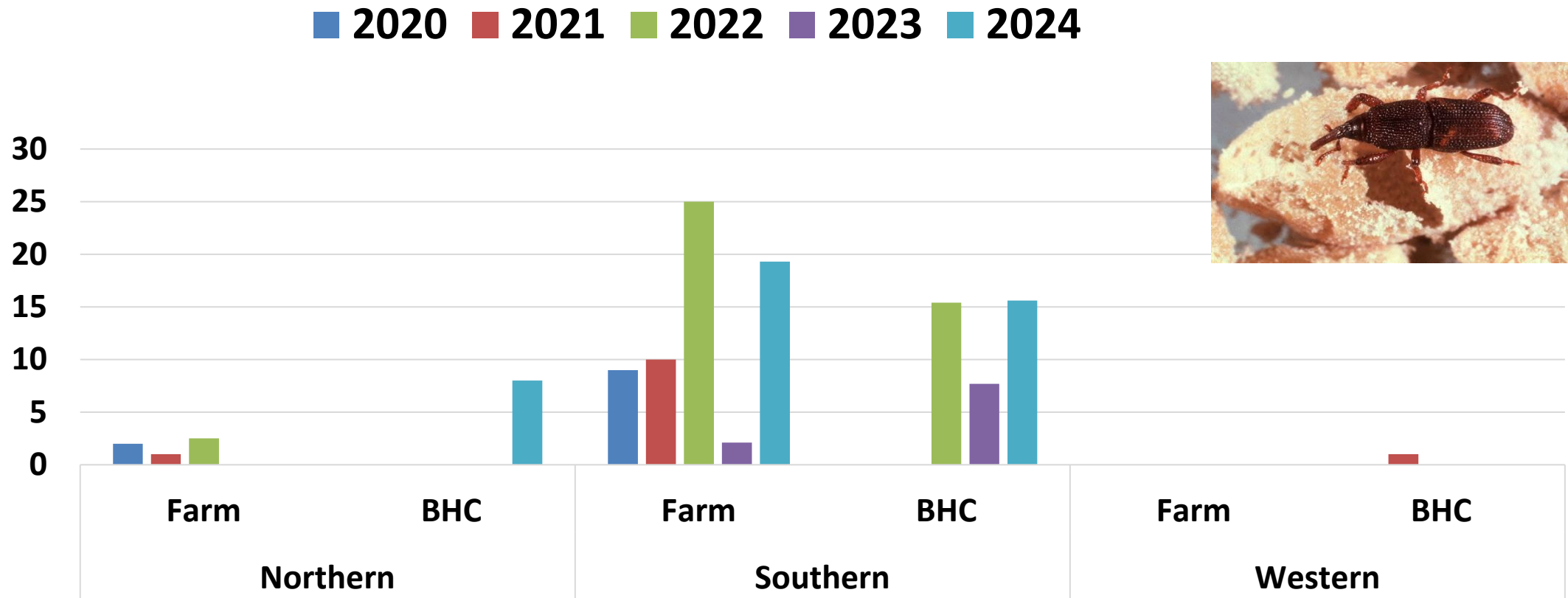
Frequency (%) of strong resistance in Lesser grain borer



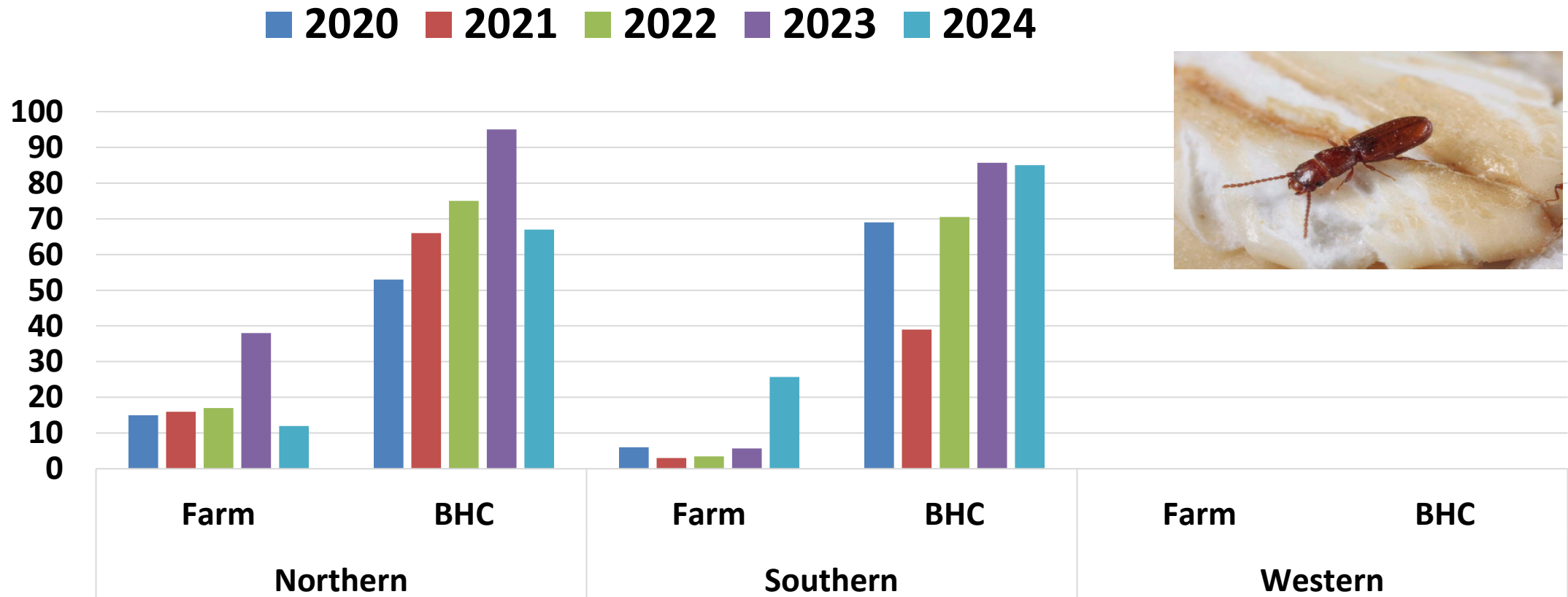
Frequency (%) of strong resistance in Red flour beetle



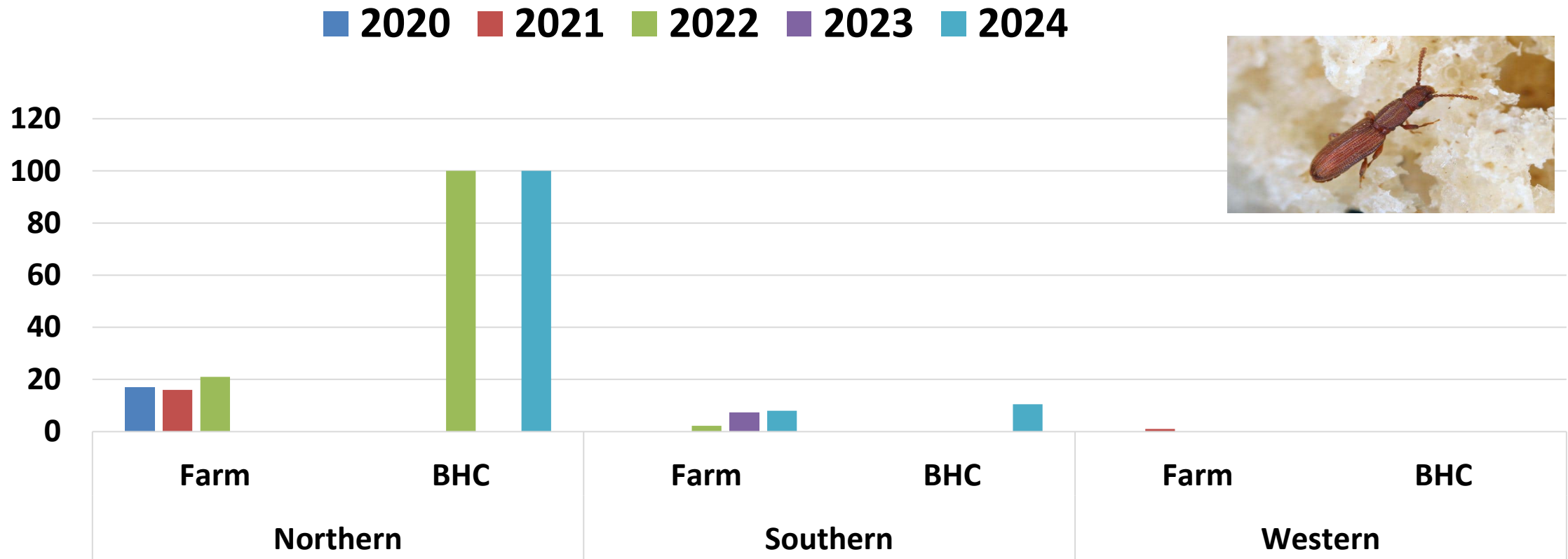
Frequency (%) of strong resistance in Rice weevil



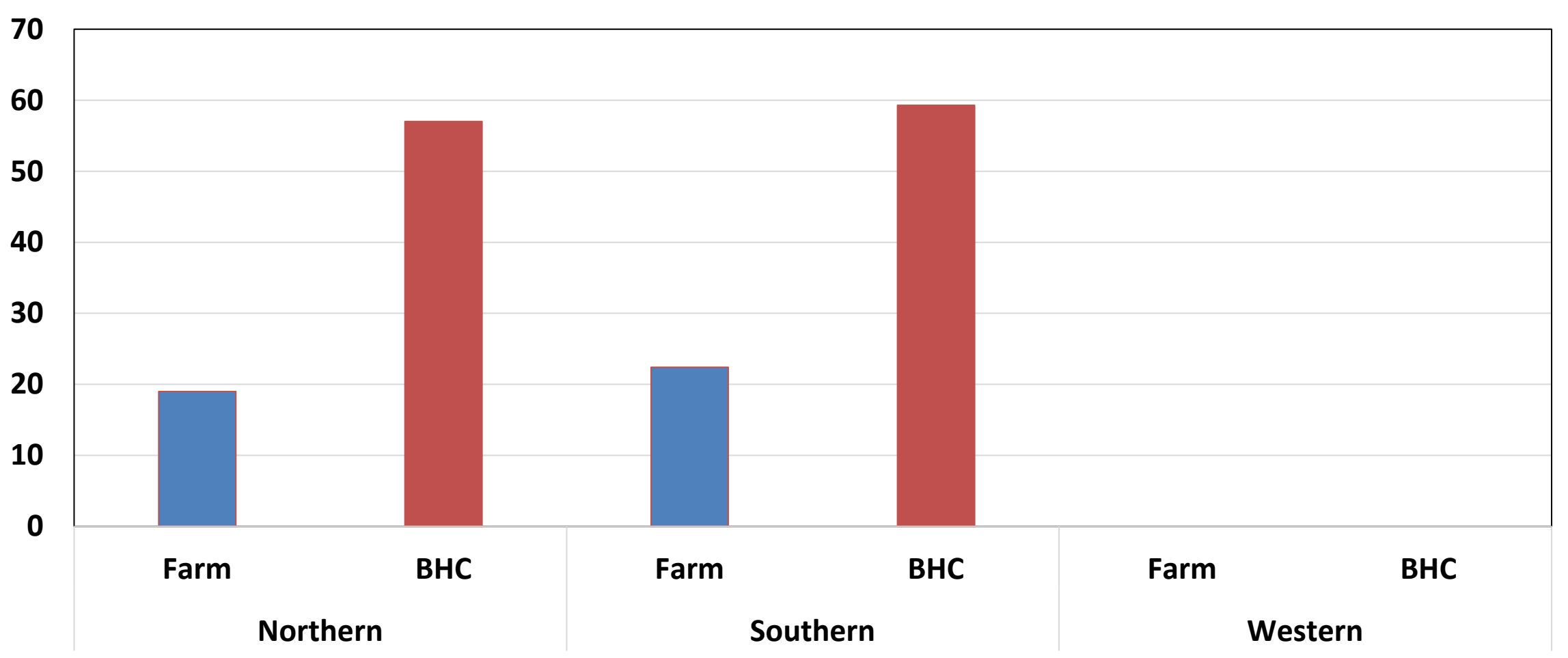
Frequency (%) of strong resistance in Rusty grain beetle



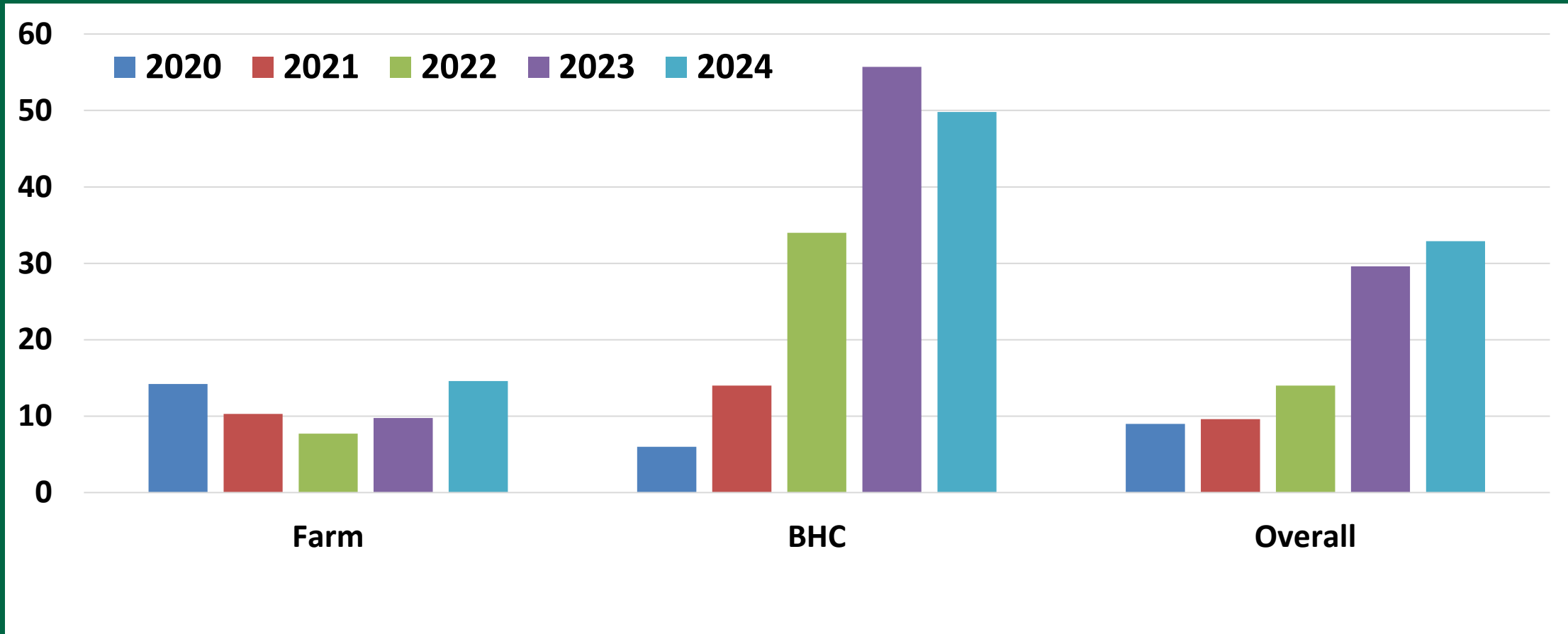
Frequency (%) of strong resistance in Saw-toothed grain beetle



Frequency (%) of strong resistance to phosphine - 2024



Trend in strong resistance frequency (%) nationally



Update on monitoring for sulfuryl fluoride

- 13 RFB (*Tribolium castaneum*) field strains tested (0.85 mg/L over 48 hrs (42 g hm⁻³))
- All strains susceptible
- No resistance development
- New discriminating dose for LGB (*Rhyzopertha dominica*) - 0.4 mg/L over 48 hrs (20g hm⁻³)



Update on monitoring of grain protectants

- 36 farm strains and three BHC strains (covering three regions) of lesser grain borer (*R. dominica*) tested for resistance to spinosad
- Discriminating dose (1 ppm)
- Complete control (100%) of adults and progeny
- Combined treatment effective against field populations



Key findings

Problematic species

- *Farms:* LGB, RFB, RW and RGB
- *BHCs:* RGB (southern and northern), RW and RFB (Western)

Frequency of strong resistance to phosphine

- Data on BHCs - biased - samples from control failures
- National frequency – steady increase – doubled in one year – **33%** - all-time high

Resistance to SF and spinosad not yet detected in field populations

Industry interaction

- Face-to-face workshop with GrainCorp pest control managers and ground staff - Goondiwindi (April)
- Meeting farmers during sampling, advising them on 'best management practices'
- GRDC Grain storage update - on-line (11th June)
- Controlled Atmosphere and Fumigation Conference (CAF-2024) – Canada (Aug)
 - Manoj – Keynote and Workshop Talk on 'Resistance Management'
 - Raj – Talk on IPM for Northern Australia
 - Co-authored Book Chapter – “Insect Resistance to Fumigants in Postharvest Commodity Protection - Monitoring and Management”

Ongoing research

- Establishing 'safe venting periods' for on-farm phosphine fumigation
- Development of a 'quick' test for detecting strong resistance in RFB
- Phosphine protocols for strongly resistant rusty grain beetle
- Best Management Practices for Phosphine



Future direction

Phosphine

- 'Safe venting periods' – across commodities, storages, temperatures
- 'Quick tests' for other spp., protocols for strongly resistant rusty grain beetle
- Base-line response of other spp. (RGB most updated)
- RD&E on pests of oilseeds? (note: oil seeds can be highly sorptive)
- Developing protocols for exotic pests (eg. Khapra) - International collaboration

Grain protectants

- Potential of SAS to manage resistant pests
- New data on fenitrothion (both as grain protectant and structural treatment)

Acknowledgements



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- Viterra: Greg Hopkins and Staff
- Grainflow: Kain McGregor and Staff

Thank you

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**“Creativity is intelligence having fun”
Albert Einstein**

