**Australian Agronomy Conference**
Albany, 22-24 October, 2024

# Potassium rundown in grain cropping and the emergence of potassium deficiency on loamy soils

**Richard Bell, Craig Scanlan, Miaomiao Cheng**

SOILSWEST

Department of Primary Industries and Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

MU

# Main findings

1. Yield responses to K fertilizer now demonstrated on loamy soils due to run down in soil K levels.
2. On loam soils, topdressed K rates of 100-200 kg K/ha gave maximum wheat grain yield
3. Soil test K levels required to avoid K deficiency on loamy soils appear to be higher than those used for sands and sandy duplex soils.
4. Sampling 0-40 cm depth gave more reliable estimates of wheat response to K than 0-10 cm.

# Oat response to K supply off the windrow at Brookton on loamy soil

| Depth (cm) | Colwell K (mg/kg) |
|---|---|
| 0-10 | 40 |
| 10-20 | 22 |
| 20-30 | 21 |
| 30-40 | 21 |

# Average K removal in grain (kg/ha)

| Grain yield (t/ha) | Wheat/ barley/ oats | Canola | Lupin/ field peas/ faba beans |
|---|---|---|---|
| 1 | 4-4.5 | 9 | 8-10 |
| 2 | 8-9 | 18 | 16-20 |
| 3 | 12-13.5 | 27 | 24-30 |
| 4 | 16-18 | 36 | 32-40 |
| 5 | 20-22.5 | | |

Ma et al. (2022)

# Negative K balances ARE common across farming systems

| | K balance (kg/ha/yr) |
|---|---|
| Canola | -10.1 ± 0.9 |
| Lupin | -9.9 ± 1.8 |
| Barley | -7.8 ± 1.1 |
| Wheat | -5.5 ± 0.4 |
| Pasture | 0.4 ± 0.1 |
| Northern Ag | -3.8 ± 0.4 |
| Central Ag | -6.6 ± 0.5 |
| Southern Ag | -8.6 ± 0.7 |

Harries et al. (2021) – 2010 to 2015 on 184 farms mostly in medium rainfall zone

# Potassium – Declining trends in most Ag-Zones


Red line is the critical Colwell K level (Brennan and Bell 2013)

CSBP

**Ma et al. (2022)**

# Low Colwell K is now widespread in subsoils

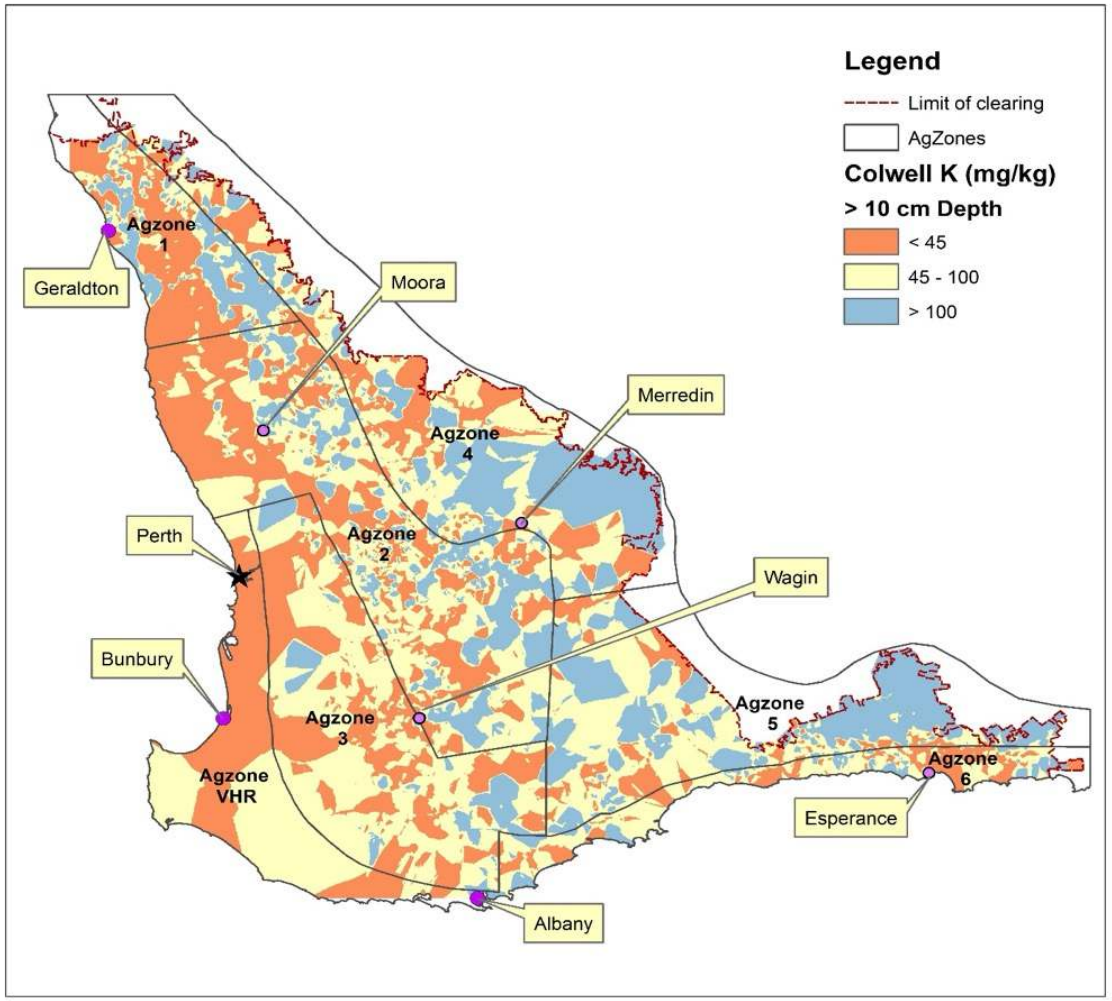
**Subsoil 10–30 cm**

- **42%  <35 mg K/kg,**
- **79%  <100 mg K/kg**

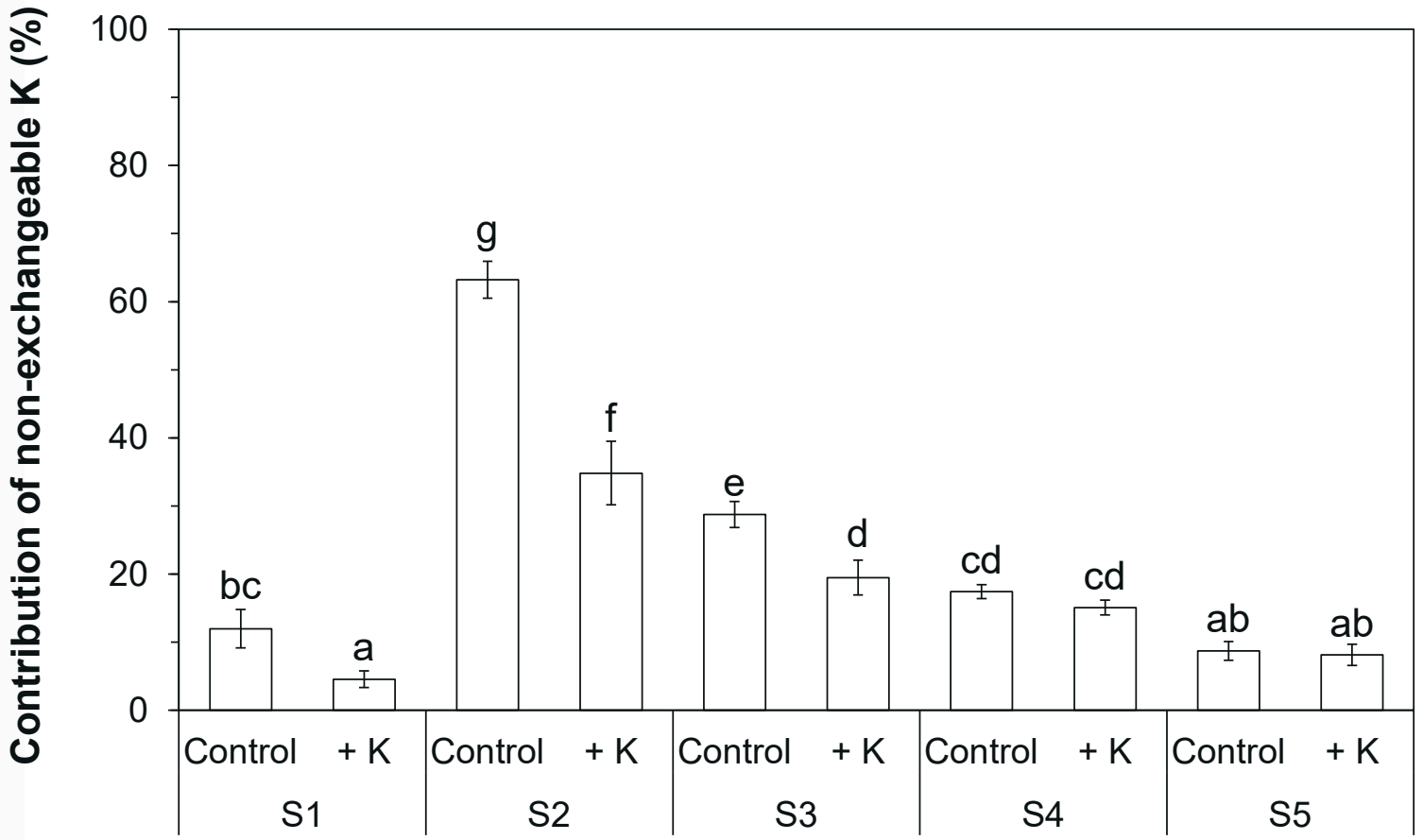
**Based on the 2016–2019 study, CSBP**

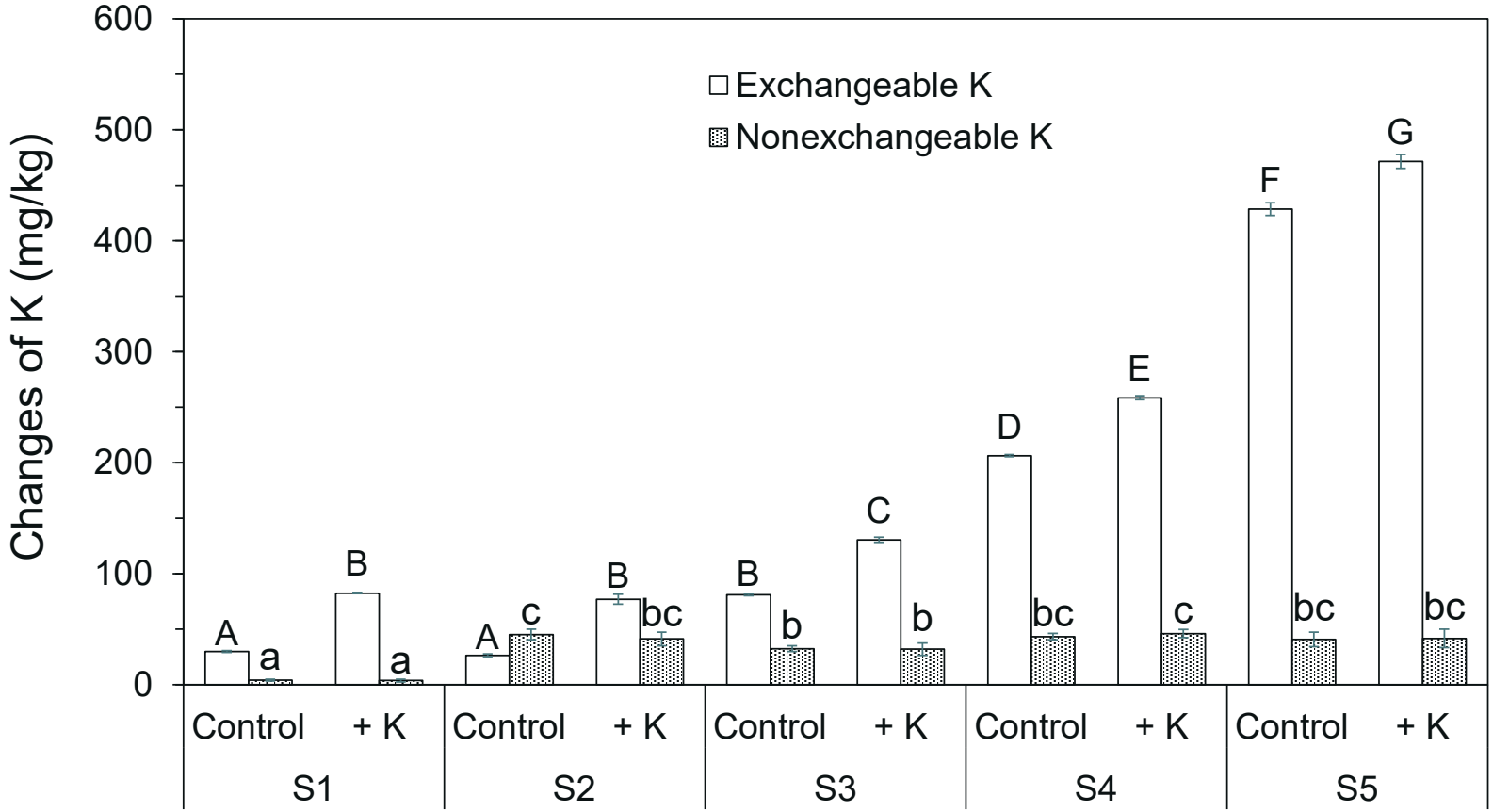
CSBP

**Ma et al. (2022)**



# Limited contribution of non-exchangeable K to total plant K uptake




Changes of K (mg/kg)
600
500
400
300
200
100
0
Exchangeable K
Nonexchangeable K
A
a
B
a
A
c
B
bc
B
b
C
b
D
bc
E
c
F
bc
G
bc
Control
+ K
S1
S2
S3
S4
S5

# Locations and soil types of K experiments – Northam to Beverley

| Location | Year | Soil type (WA Soil Group)* |
|---|---|---|
| Burges Siding, N of York | 2021, 2022 | Red loamy earth |
| East of Greenhills | 2021 | Brown loamy earth |
| South of Greenhills | 2021 | Red loamy earth |
| East Beverley | 2021 | Red loamy earth |
| Northwest Quairading | 2022 | Yellow brown deep sandy duplex |
| East Beverley | 2022 | Red deep sandy duplex |
| South of York | 2022 | Reticullite deep sandy duplex |



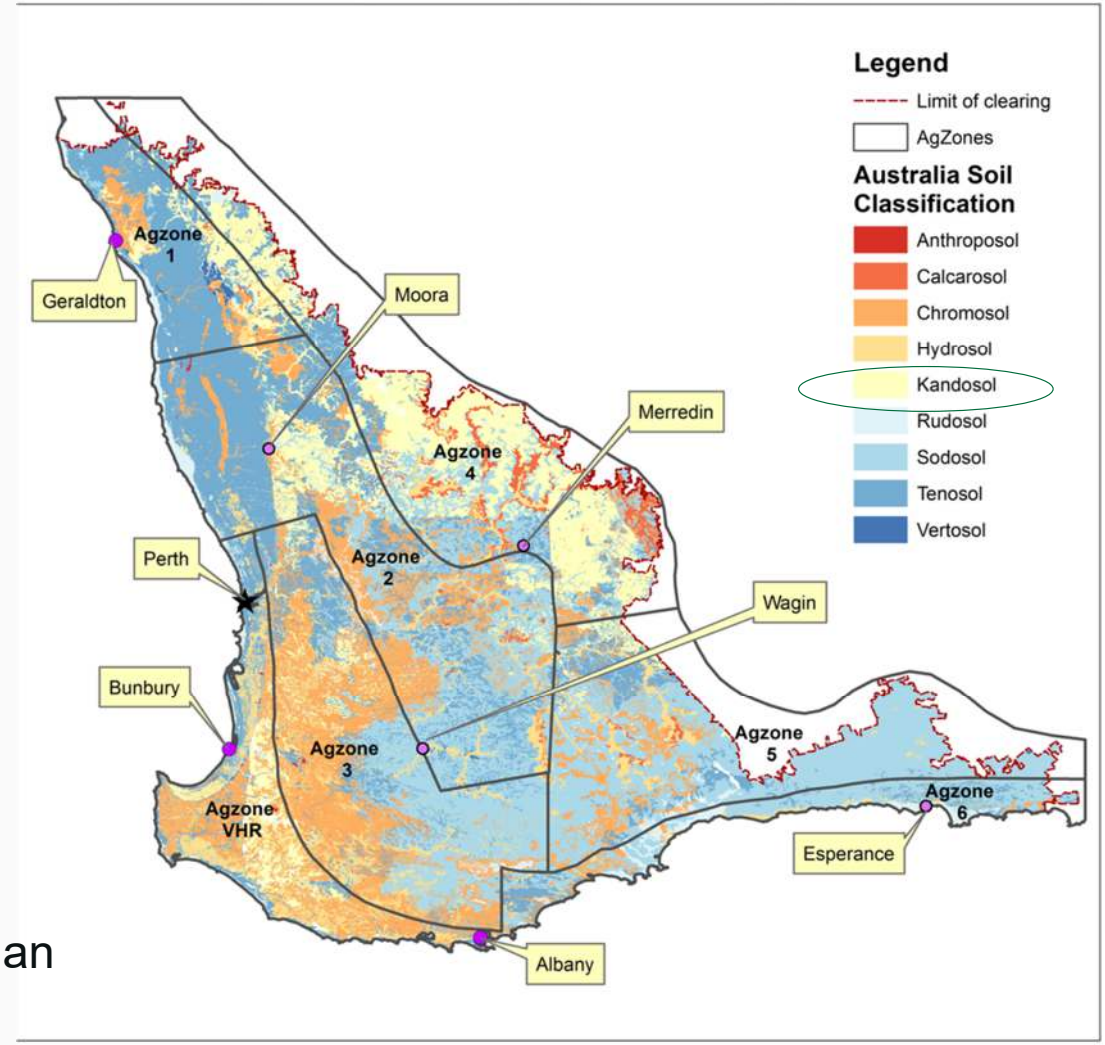
*Soil classification by Shahab Pathan, DPIRD

# What do these soil profiles look like?


Red loamy earth
(North of York)

Department of
Primary Industries and
Regional Development
GOVERNMENT OF WESTERN AUSTRALIA

- Red loamy earth
- Red Kandosol




Described by Shahab Pathan

# Wheat yield responses to K on loamy soils in 2021

*K deficient loam - York*

*K responsive loam – E Beverley*

Colwell K (mg/kg)

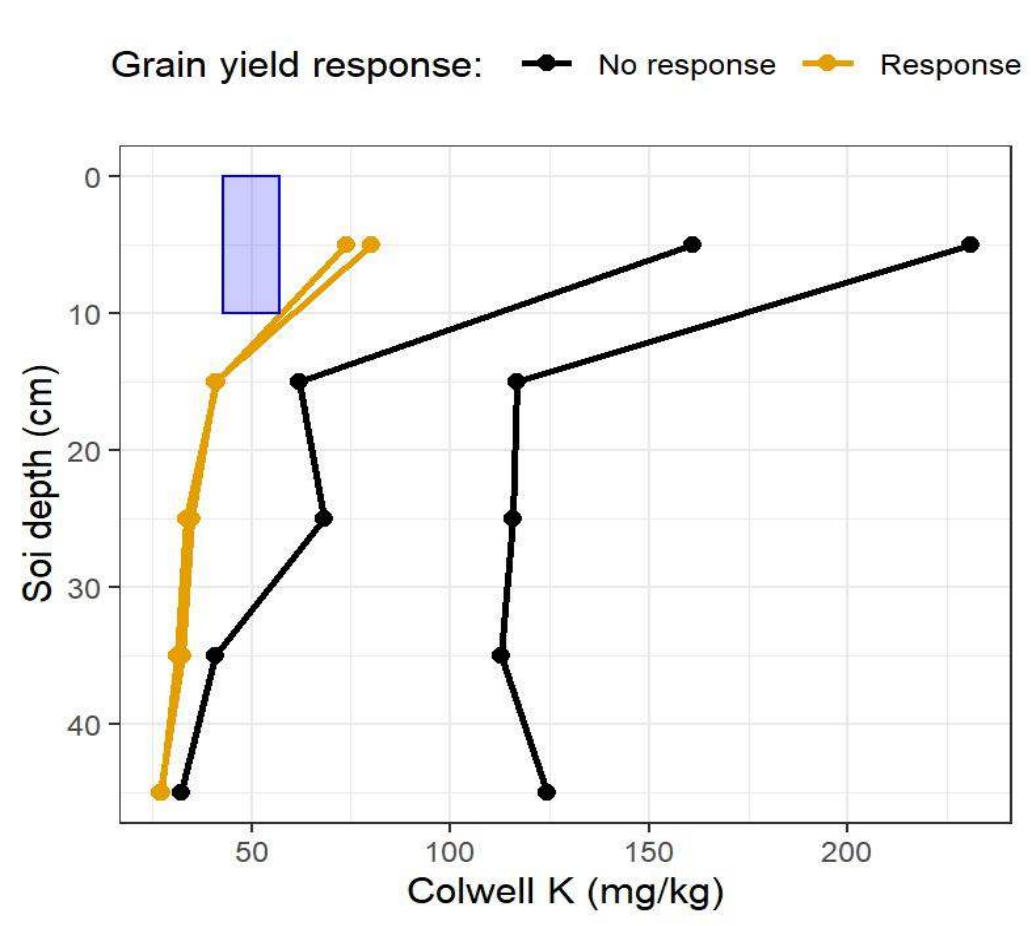
| Depth (cm) | York | E Beverley |
|---|---|---|
| 0-10 | 80 | 74 |
| 10-20 | 41 | 41 |
| 20-30 | 35 | 34 |
| 30-40 | 33 | 31 |
| 40-50 | 27 | 27 |

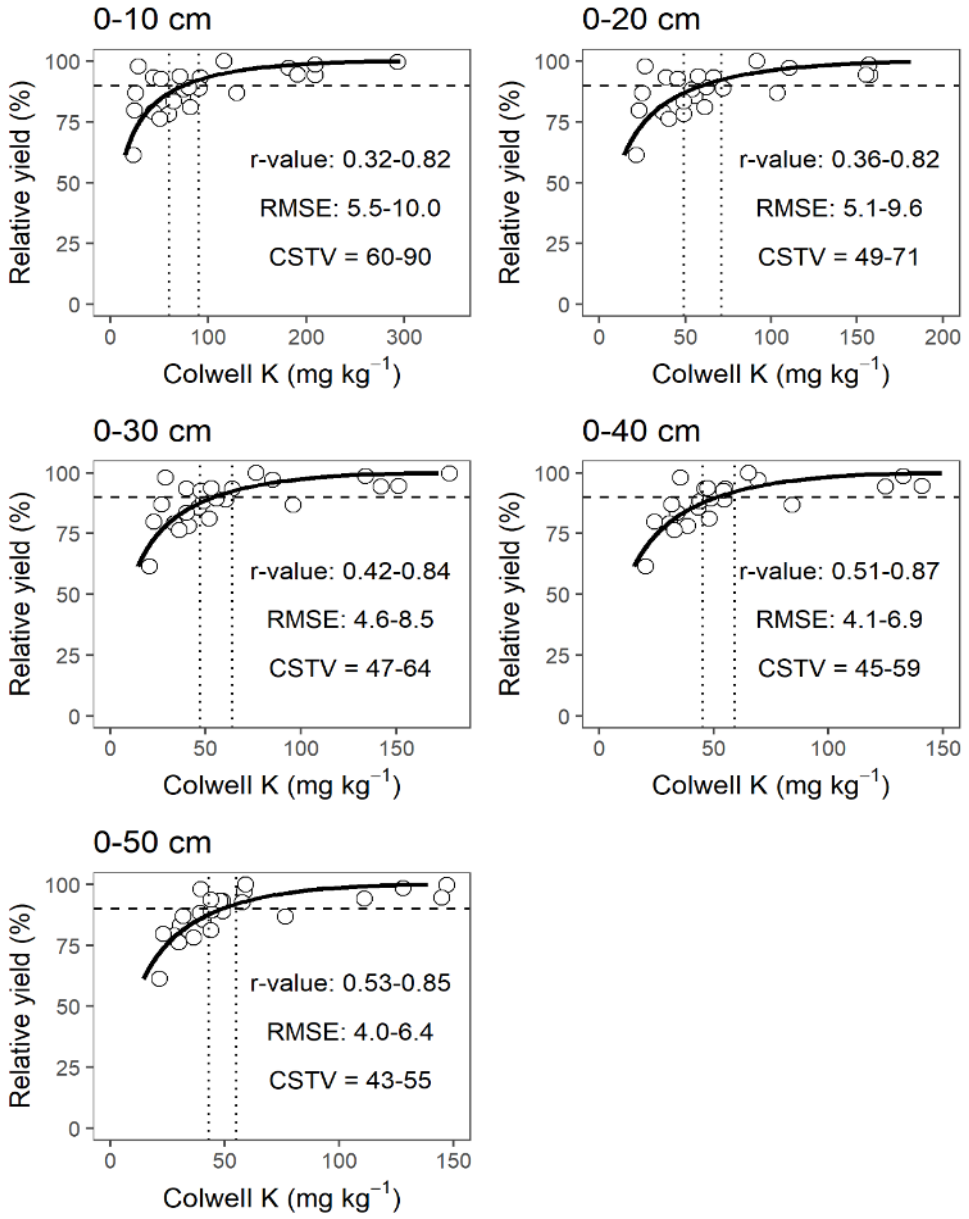
Grain yield (t/ha)

| K rate (kg/ha) | York | E Beverley |
|---|---|---|
| 0 | 4.8 a | 4.4 a |
| 25 | 4.9 ab | 4.5 ab |
| 50 | 5.0 ab | 4.6 abc |
| 25+25 | 5.1 b | 4.8 bc |
| 100 | 5.1 b | 4.9 c |
| 200 | 5.5 c | 5.3 d |

Scanlan et al. CPS 2025

# Loamy soils  may need a higher critical Colwell K range to predict K deficiency






# Soil test calibrations for increasing soil depths

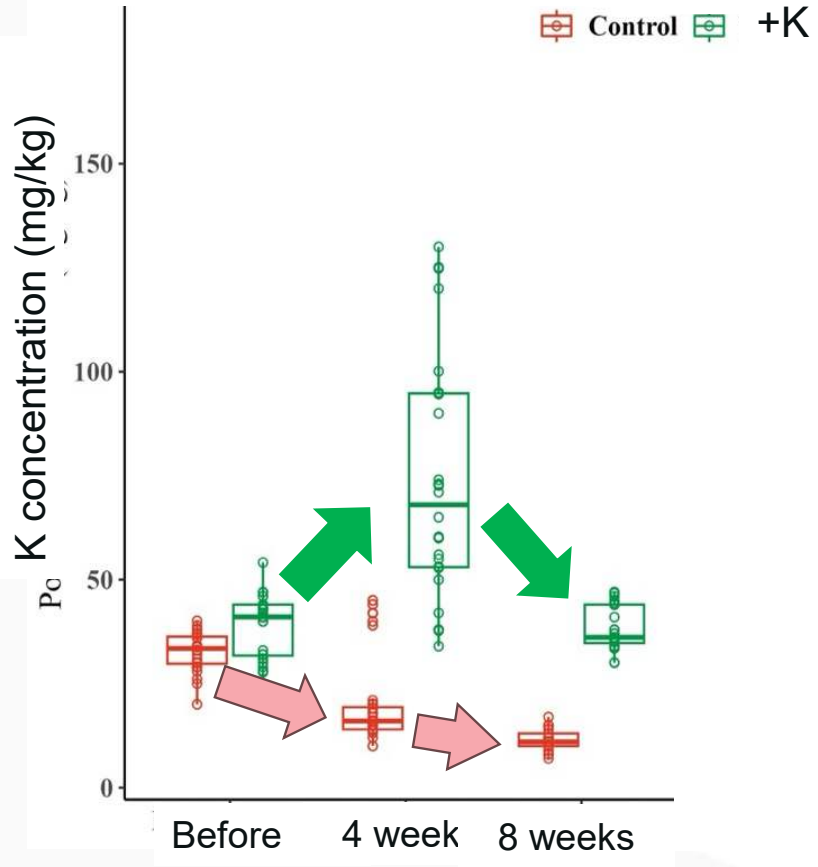
**Sampling to 0-40 cm gave best prediction of K response**

# KEY MESSAGES

- K rundown in soils, including loam soils
- Check soil test results for K before sowing including subsoils and on loamy soils
- Use windrowing effects in crops to identify emerging K responses (use plant and soil tests in season to confirm)
- Calculate K balances in cropping fields on loamy soils, especially where hay production occurs

# Key questions

- K leaching and factors triggering K loss- our recent research suggests high rates of K leaching from broadcast K applied at seeding
- Role of deep-rooted crops (e.g. lupin) in rotations to recycle K



# Acknowledgements


- GRDC investment: Increasing profit from N, P and K fertiliser inputs into the evolving cropping sequences in the Western Region (UMU1801-006RTX, UWA1801-002RTX).
- Growers



- Qifu Ma[1], Tim Boyes[3], James Easton[4]

[1] SoilsWest, Murdoch University

[3] Agvivo, Bentley

[4] CSBP, Kwinana

# Typical K removal in hay (kg/ha)

| Yield (t/ha) | Oats | Wheat |
|---|---|---|
| 1 | 8-15 | 12 |
| 2 | 16-30 | 24 |
| 4 | 32-60 | 48 |
| 7 | 56-105 | 84 |
| 10 | 80-150 | 120 |

James Easton, Ma et al. (2022)