pH in Furrow – Lime Amendment

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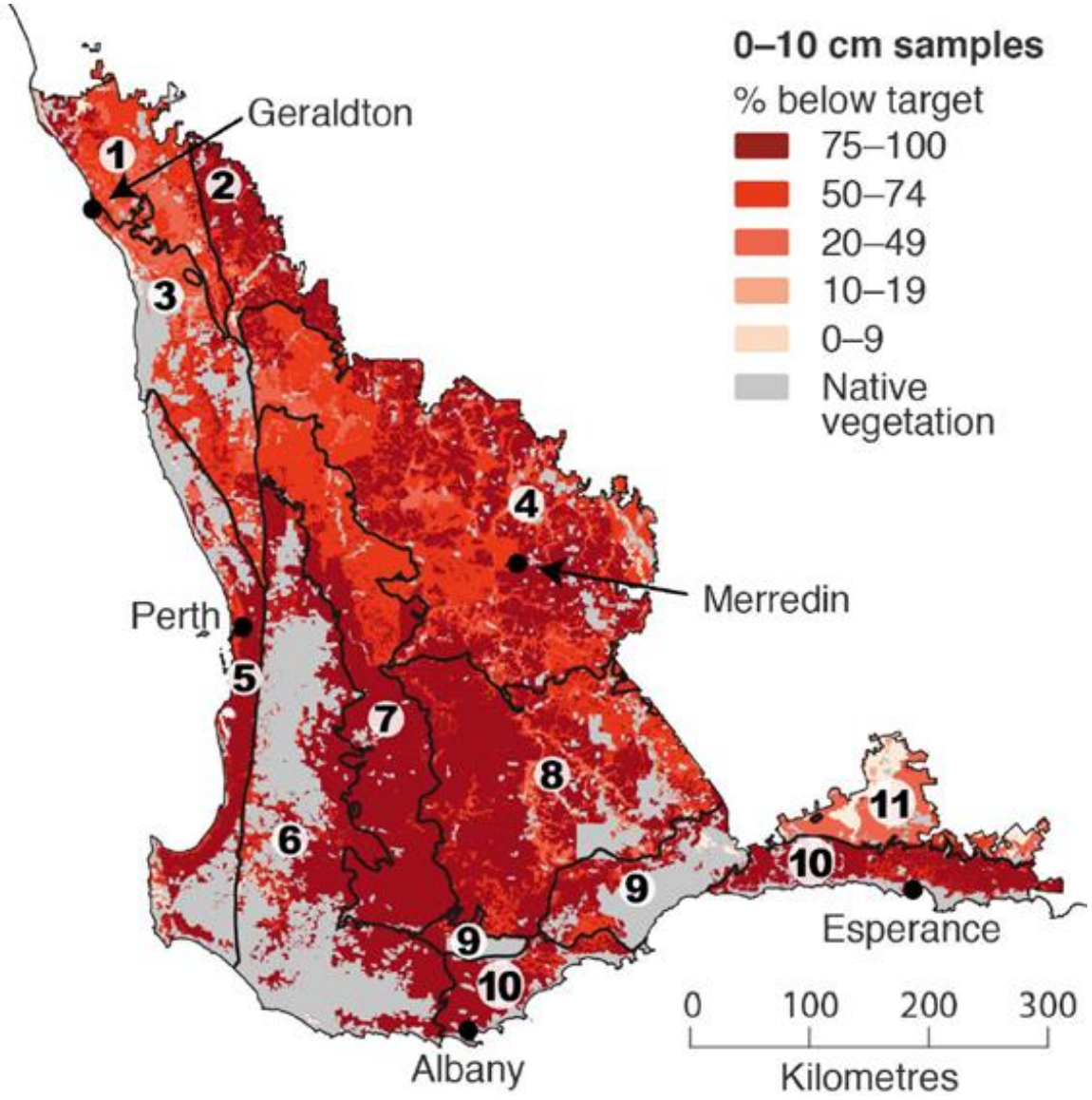
Surface soil pH in WA wheat belt

Major findings

- 72% of surface soil samples below minimum target (pH_{ca} 5.5)



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How much acidity in a pH value?

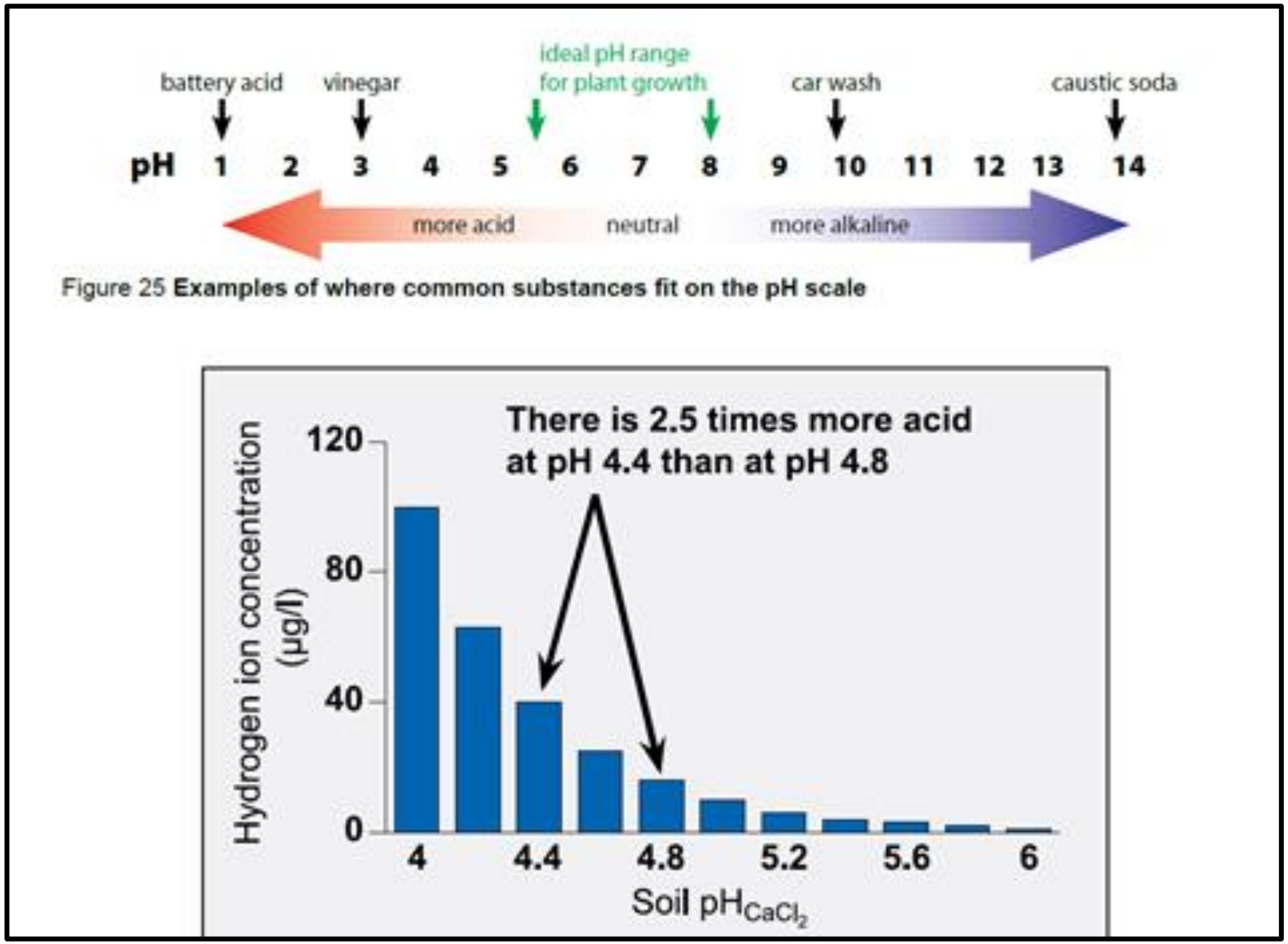


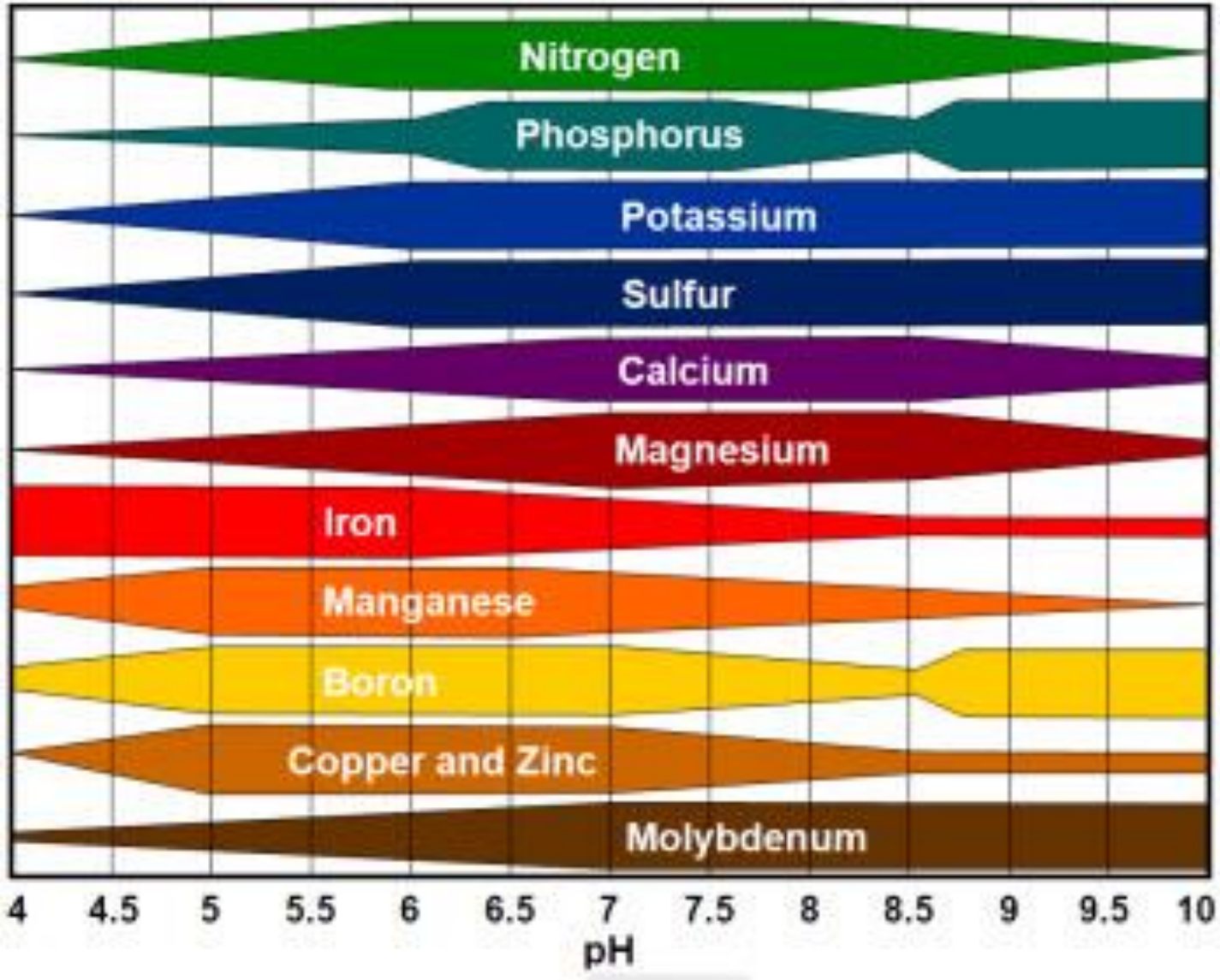
Figure 25 **Examples of where common substances fit on the pH scale**

What happens in a low pH soil or subsoil?

- Nitrifying organisms prefer a pH above 5.5
- Nitrification proceeds rapidly where there is an abundance of exchangeable Ca^{2+} and Mg^{+}
- Nitrogen is lost as nitrous oxide if soil pH is acidic
- Cannot build soil organic carbon effectively below pH5.5
- **At pH below 4.5, Iron and Aluminium become toxic and lock up phosphate**
  - This lockup is compounded exponentially for every pH decrease of 0.1 below 4.5
  - Essential elements like Cu, Mo, B etc become less available.
- Moisture in the subsoil becomes unavailable to crops through poorly developed root systems damaged by low pH and Aluminium toxicity.

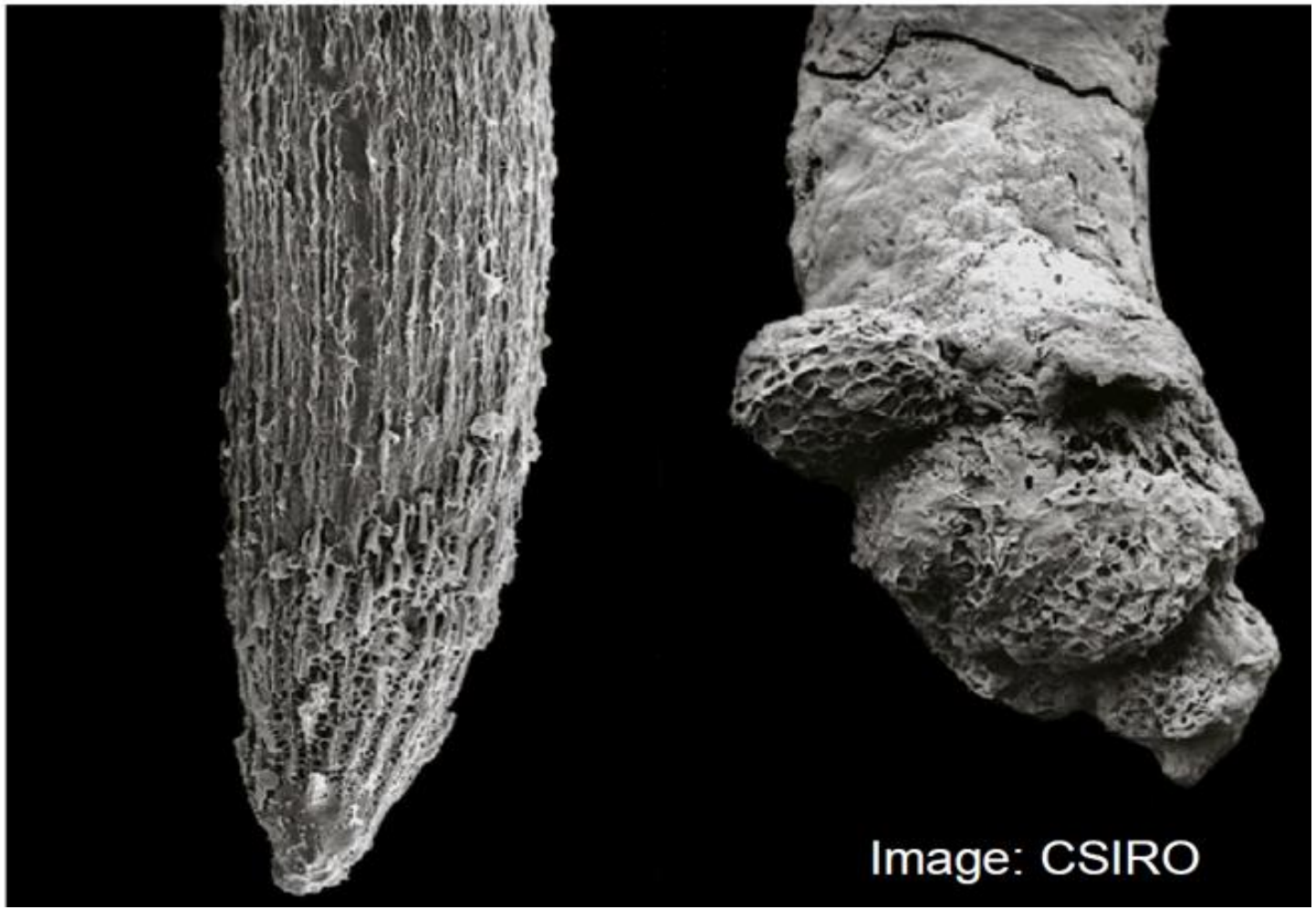
pH affects the availability of nutrients to plants

Importance of getting soil pH correct



Impact of soil acidity – subsurface acidity

- Aluminium toxicity (manganese toxicity, rare in WA)
- Decreased root growth
- Reduced access to subsoil moisture
- Leaching of nutrients
- Poor water use efficiency
- Decreased crop choice and productivity



Healthy root tip (left) compared to a root tip affected by Aluminium toxicity (right)

Aluminium toxicity at emergence reduces early root growth

Wheat seedlings grown in soil with different Aluminium concentrations

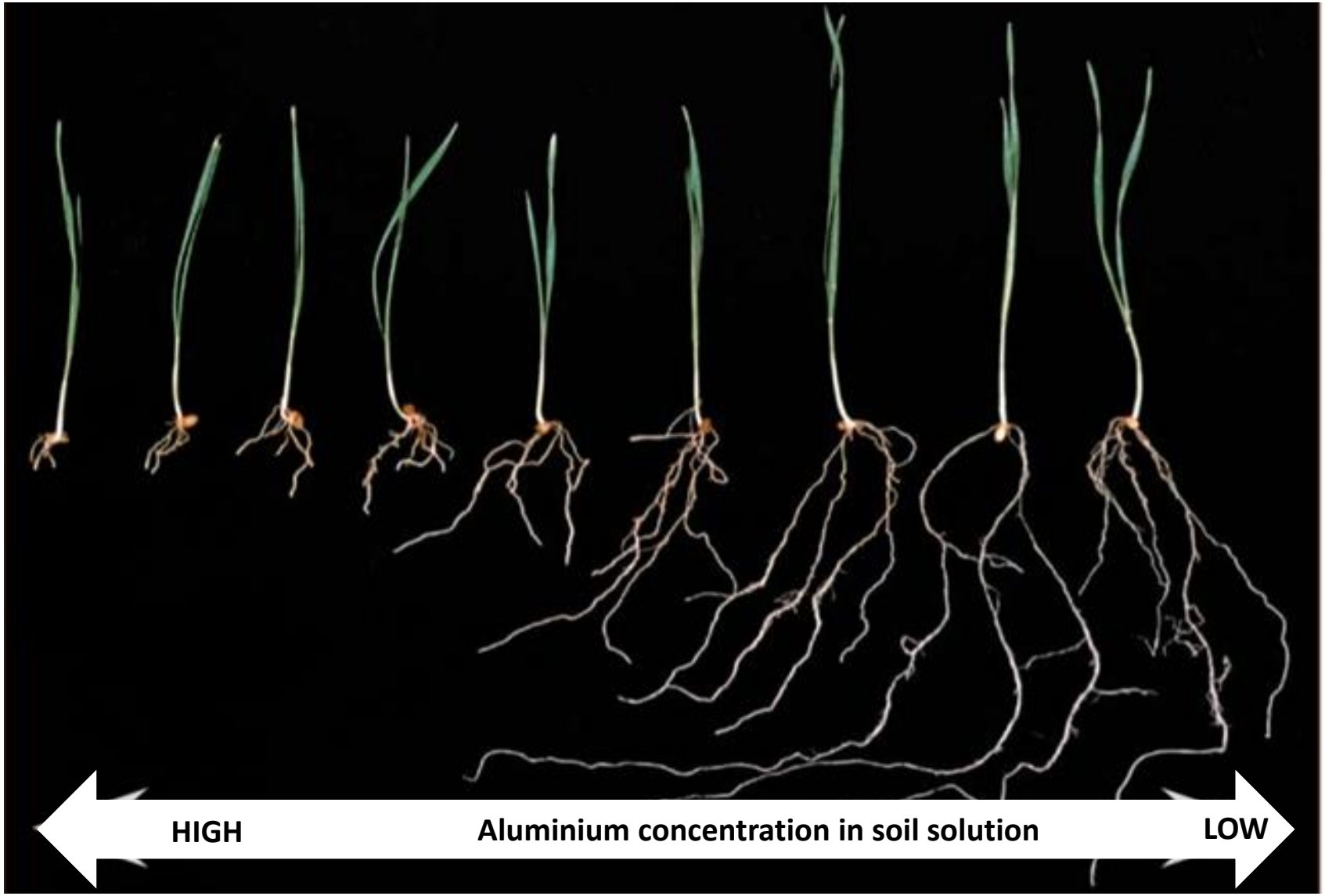


Image: Sam Carr

Relative % yield at different pH levels (H_2O)

Crop	pH 4.7	pH 5.0	pH 5.7	pH 6.8	pH 7.5
Wheat	68%	76%	89%	100%	85%
Lucerne	2%	9%	42%	100%	100%
Barley	0%	23%	80%	95%	100%
Oats	77%	93%	99%	98%	100%

Source: Mid-West Labs, Omaha NE

Managing sub-soil acidity

- Sub-soil acidity is difficult to manage.
- Vertical movement of lime is very slow and the lateral movement of lime is minimal.
- Deep placement of lime could speed up the amelioration process compared with surface liming.
- **The answer – Reduce the size of lime particles to enhance downward mobility**

Why does particle size matter?

The finer the particle size the more active and mobile lime is in the soil

Treatment	Mean particle size mm	pH
1	control	4.11
2	3	4.13
3	0.6	4.22
4	0.35	4.25
5	0.2	4.34
6	0.11	4.43
7	0.005	5.25

Soil pH ($CaCl_2$) 2 years after application and incorporation of limestone to 10 cm

B. J. Scott, M. K. Conyers, R. Fisher and W. Lill, NSW Agriculture, Agricultural Research Institute, Wagga Wagga.

Changing the soil pH and $CaCO_3$ mobility

$CaCO_3$ (0.0015 mm average particle size) more mobile than more coarse forms of lime

	Soil pH testing per trial site			
	Treatment	Limesand	Control	$CaCO_3$ (0.0015 mm)
Pre seeding 10/5/14	0-10cm	5.2	5.3	5.1
Post-harvest 12/11/14	0-10cm	5.8	4.6	5.9
	10-20cm	4.9	4.6	5.6
	20-30cm	4.8	4.9	6.1

Monthly rainfall totals Nabawa											
January	February	March	April	May	June	July	August	September	October	November	December
9.8	1.2	0.6	56	67.6	31	63	17	72.8	3.6	5	0

Stokes, Geraldton 2014

Changing the soil pH and $CaCO_3$ mobility

with $CaCO_3$ (0.0015 mm)

$CaCO_3$ creating root channel approx. 80mm

AUSPLOW trial site, Quairading, 11 July 2019
Rainfall 115mm

Control | MAP + MOP | MAP + MOP + $CaCO_3$

Results in wheat with $CaCO_3$ (0.0015 mm particle size)