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PLANT NUTRITION
INSTITUTE

Enhanced efficiency nitrogen fertilizers: Combining the right source, time, and placement

**Tai McClellan Maaz
Nitrogen Director, IPNI**

Enhanced efficiency fertilizers:

Controlled release

Stabilized N



Coated or encapsulated



Sulfur coated urea

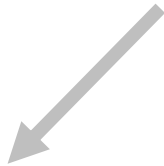
Polymer coated urea

Enhanced efficiency fertilizers:

Controlled release



Coated or encapsulated



Sulfur coated urea

Polymer coated urea

Stabilized N



Inhibitor treated



Urease

Nitrification



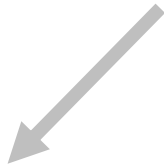
Both

Enhanced efficiency fertilizers:

Controlled release



Coated or encapsulated



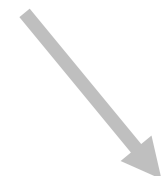
Sulfur coated urea

Polymer coated urea

Stabilized N



Inhibitor treated



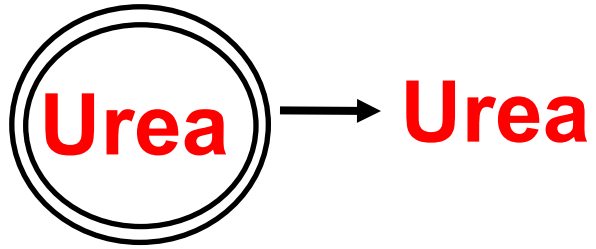
Urease

Nitrification



Both

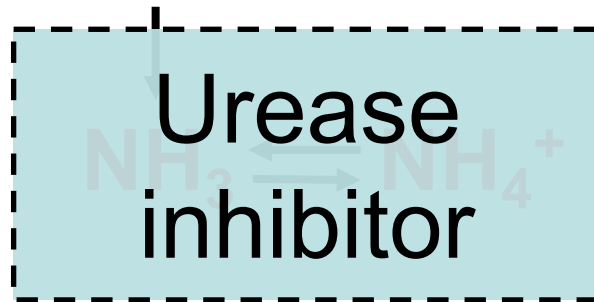
Mechanisms



Polymer coated

Mechanisms

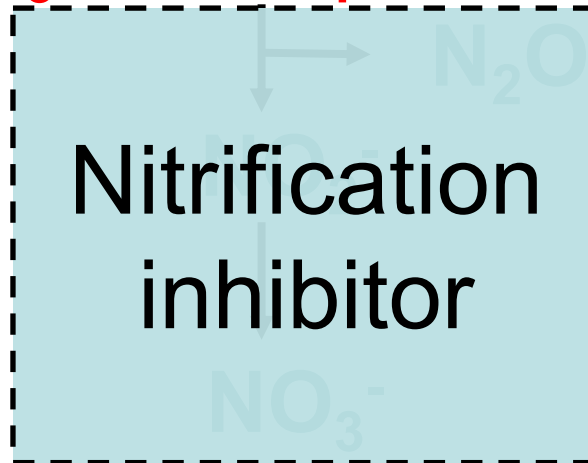
Urea



Urea hydrolysis

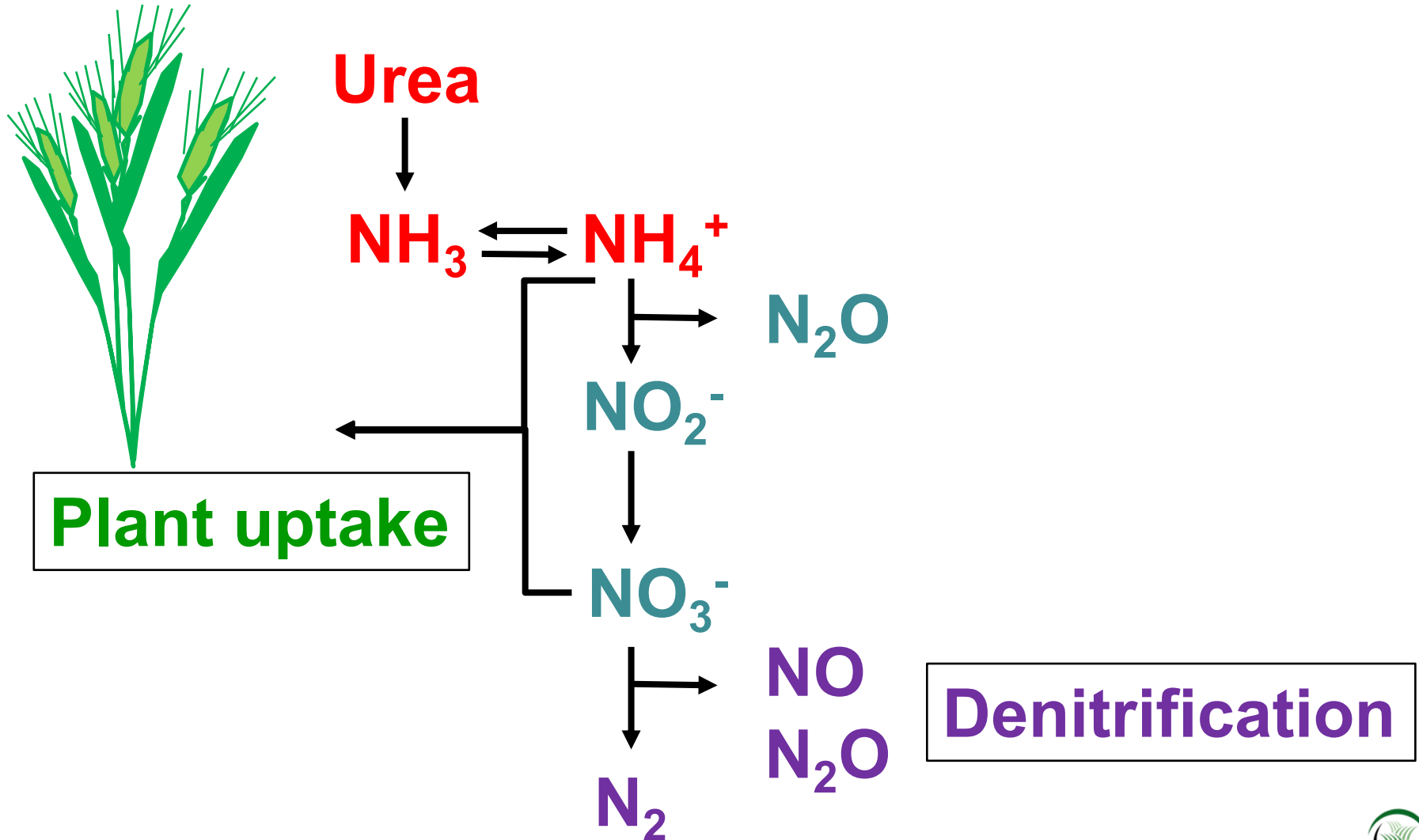
Mechanisms

Urea



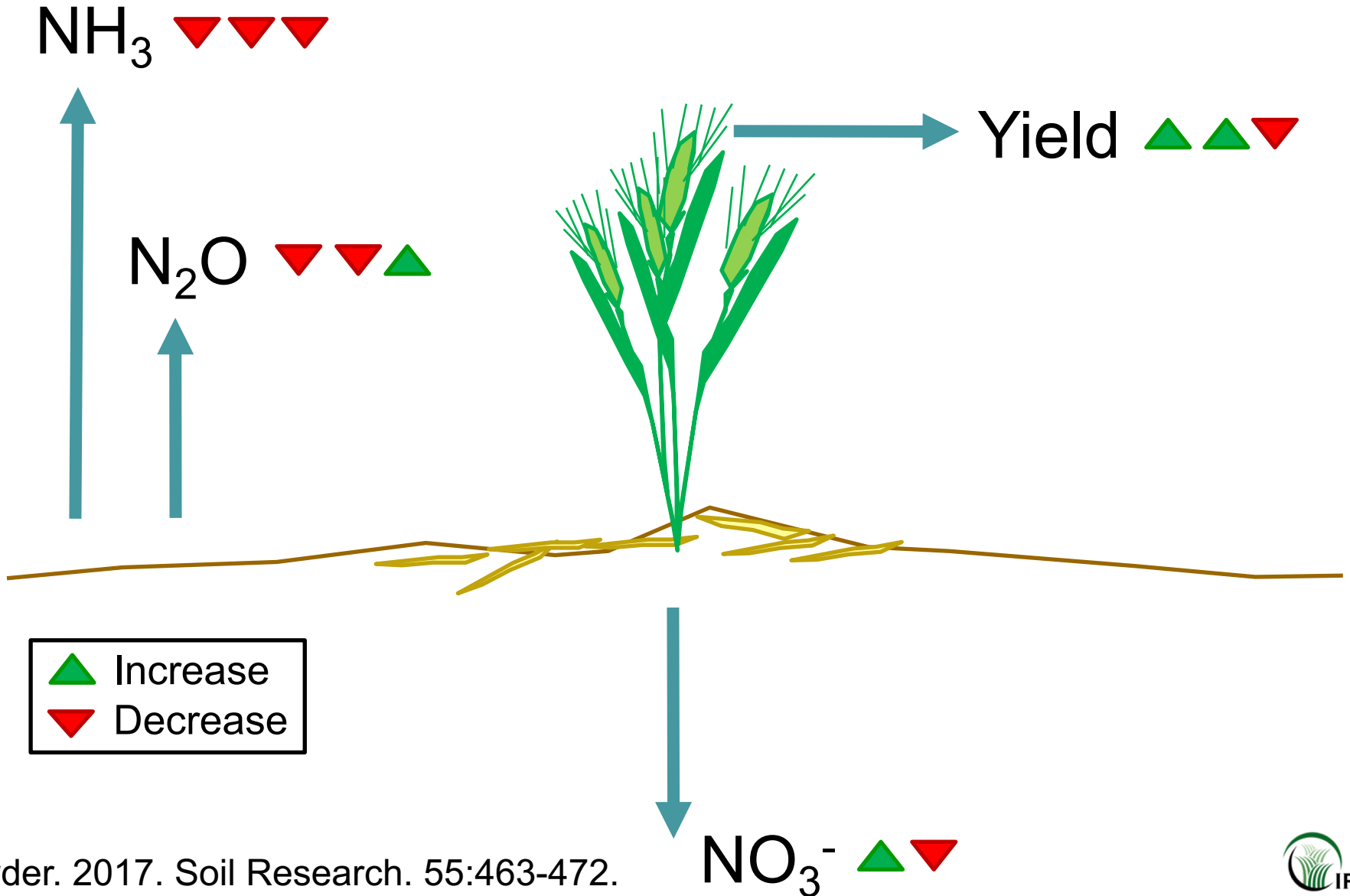
Nitrification

Mechanisms

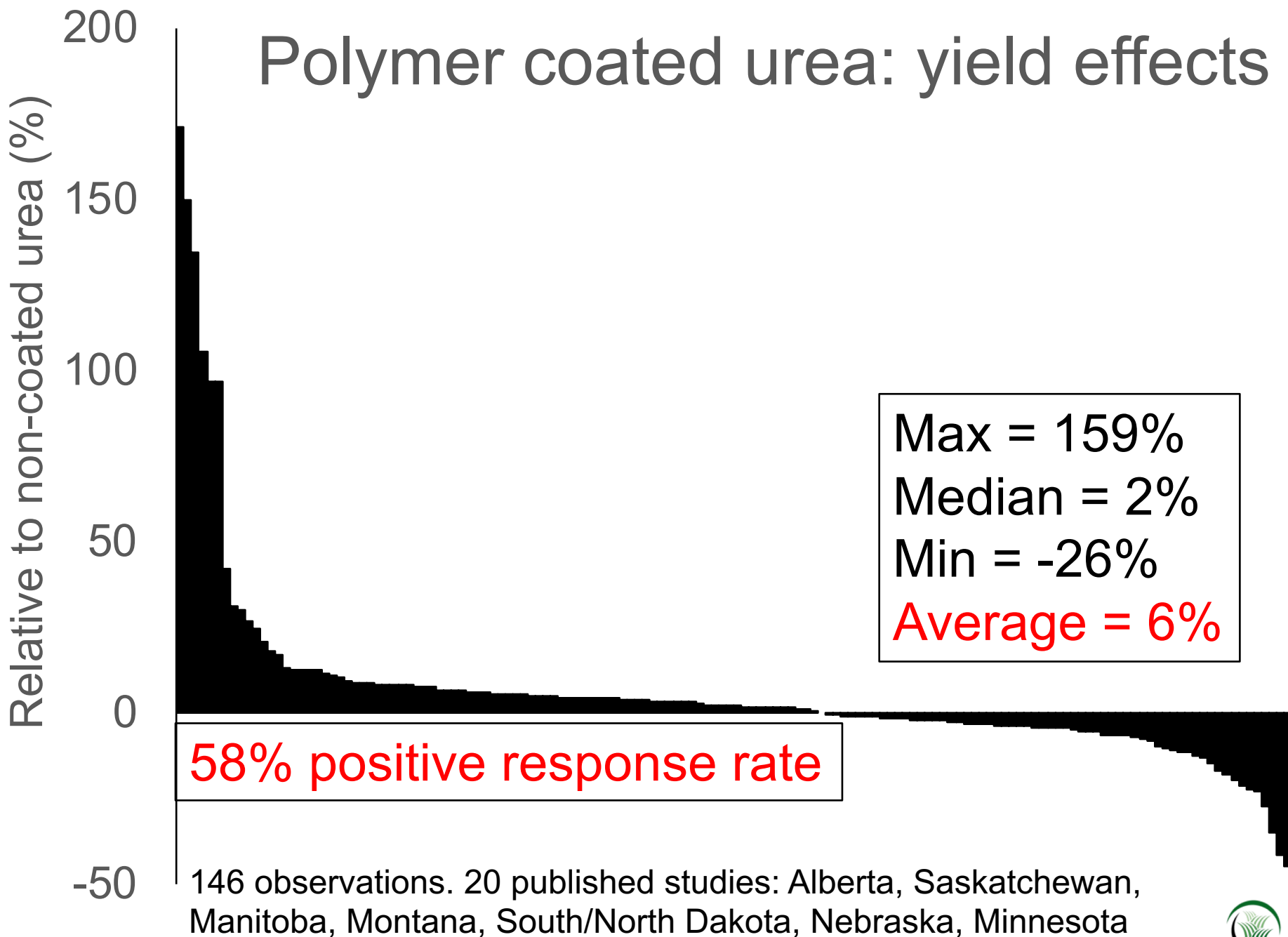


Polymer coated urea

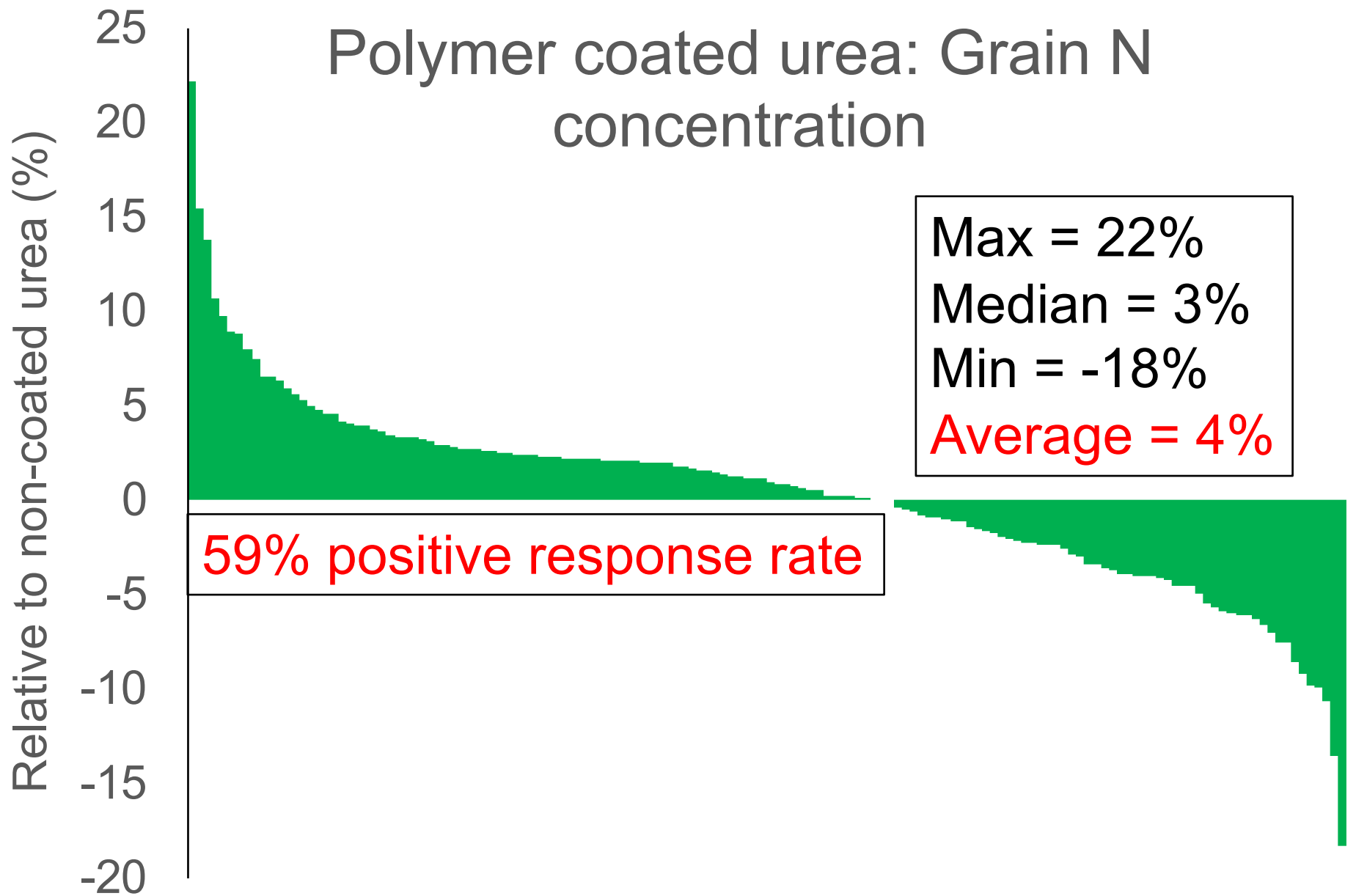
Impacts of polymer coated urea



Polymer coated urea: yield effects



Polymer coated urea: Grain N concentration

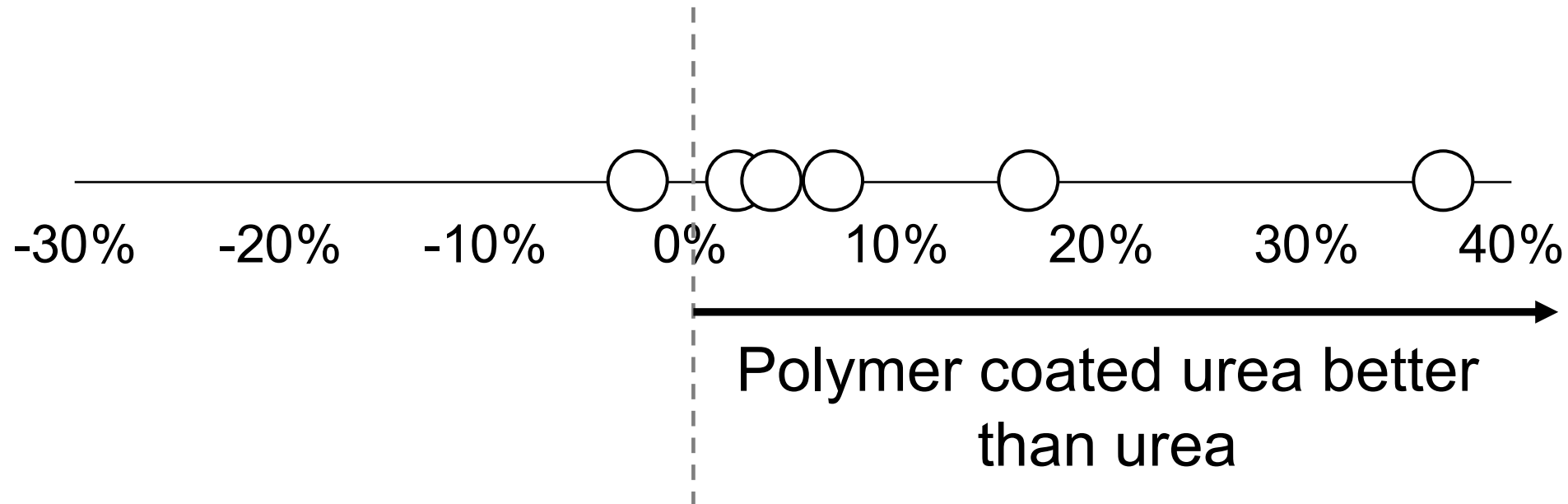


146 observations. 20 published studies: Alberta, Saskatchewan, Manitoba, Montana, South/North Dakota, Nebraska, Minnesota

When polymer coated urea outperforms

Timing

○ Fall



Winter wheat, S. Alberta: McKenzie et al. 2010. *Agron. J.* 102: 1210-1216.

Winter wheat, Montana: Mohammed et al. 2016. *Agron. J.* 108: 905-912.

Barley, C. Alberta: Nyborg et al. 1999. *Comm. Soil. Sci. Plant. Anal.* 30: 1963-1974. *Relative effects minus control

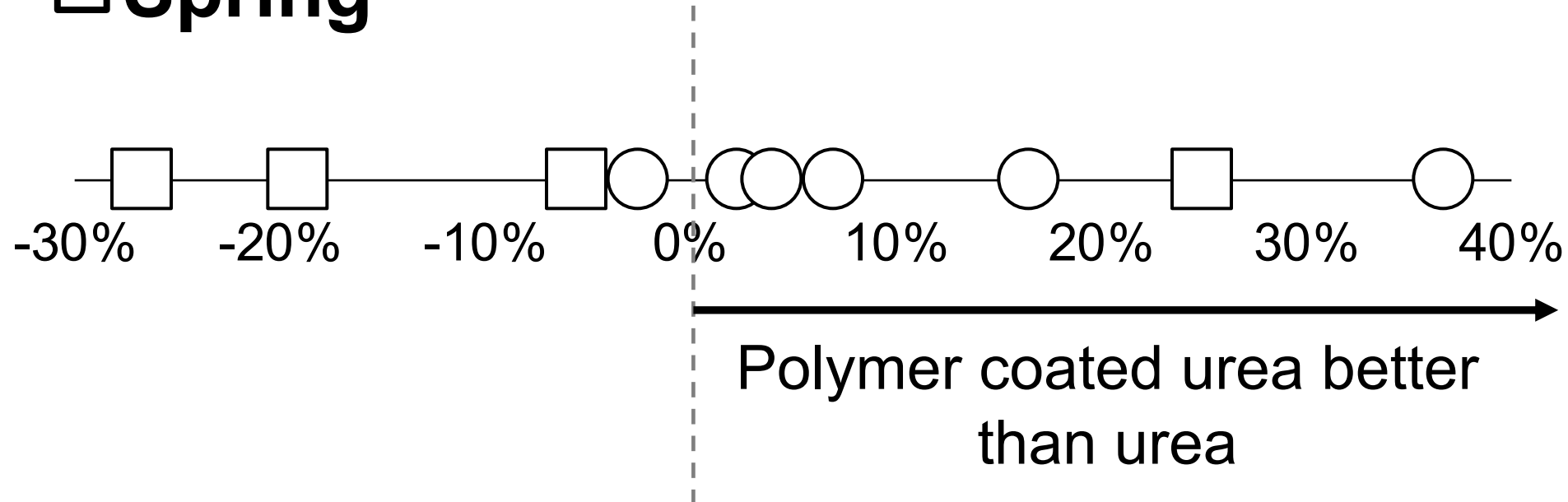
Winter wheat, S. Alberta: Middleton et al. 2004. *Can. J. Soil Sci.* 84: 125-131.

When polymer coated urea outperforms

Timing

○ Fall

□ Spring



Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216.

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When polymer coated urea outperforms

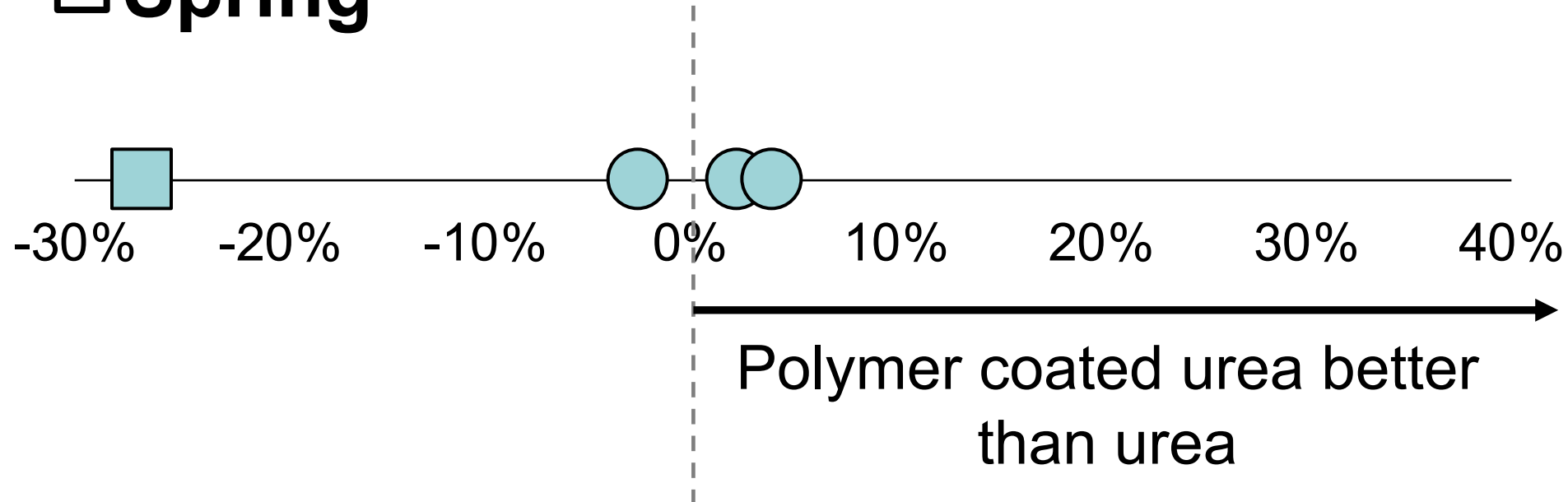
Timing

○ Fall

□ Spring

Placement

Banded



Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216.

Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.

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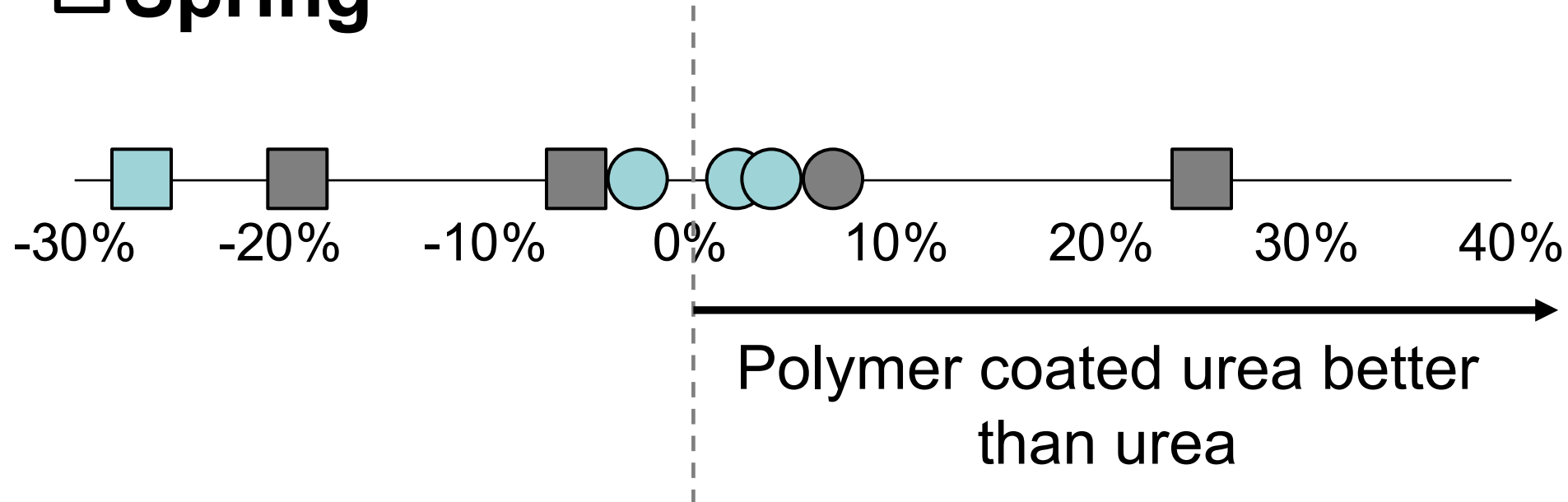
When polymer coated urea outperforms

Timing

- Fall
- Spring

Placement

- Banded
- Broadcast



Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216.

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When polymer coated urea outperforms

Timing

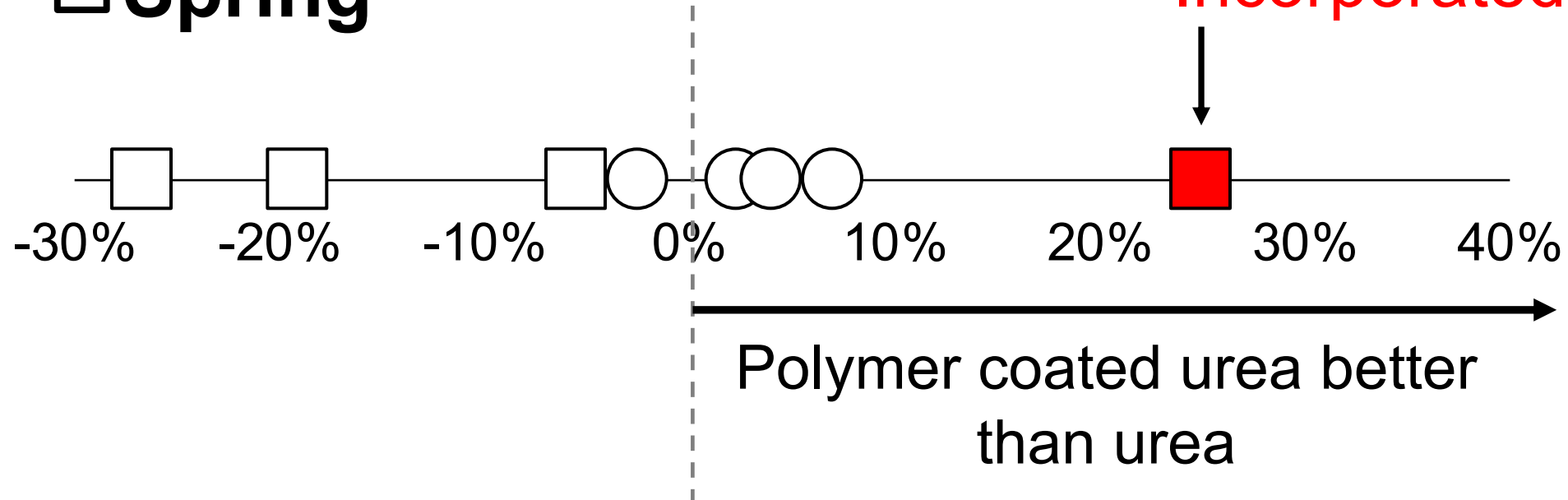
- Fall
- Spring

Placement

Banded

Broadcast

Incorporated



Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216.

Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.

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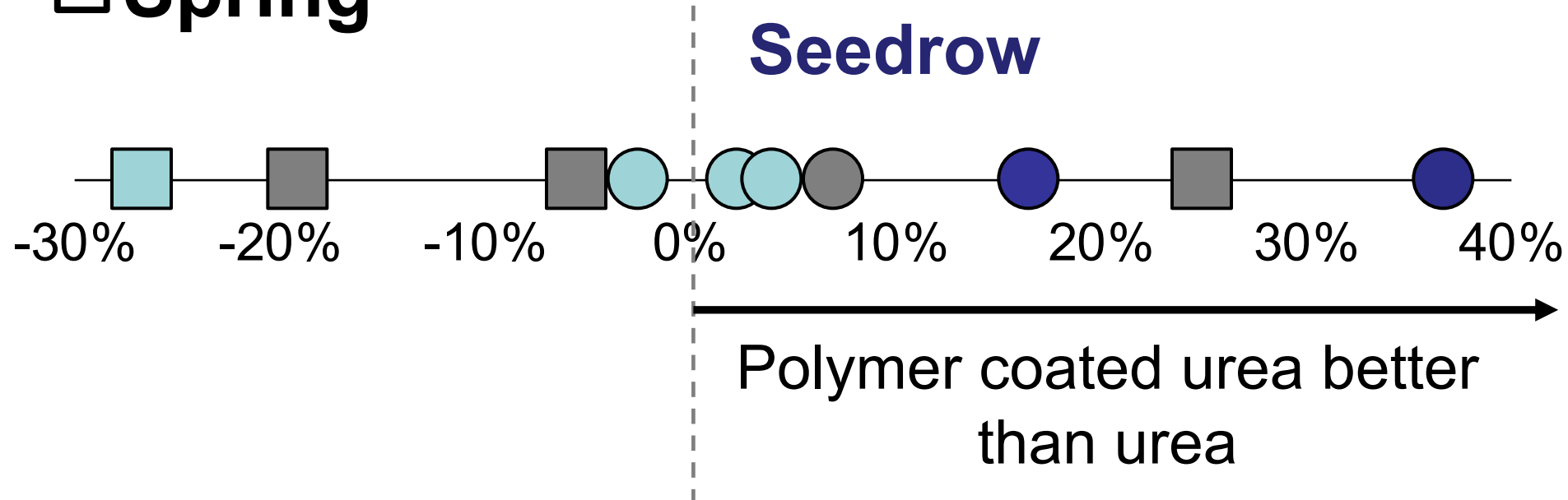
When polymer coated urea outperforms

Timing

- Fall
- Spring

Placement

- Banded
- Broadcast
- Seedrow



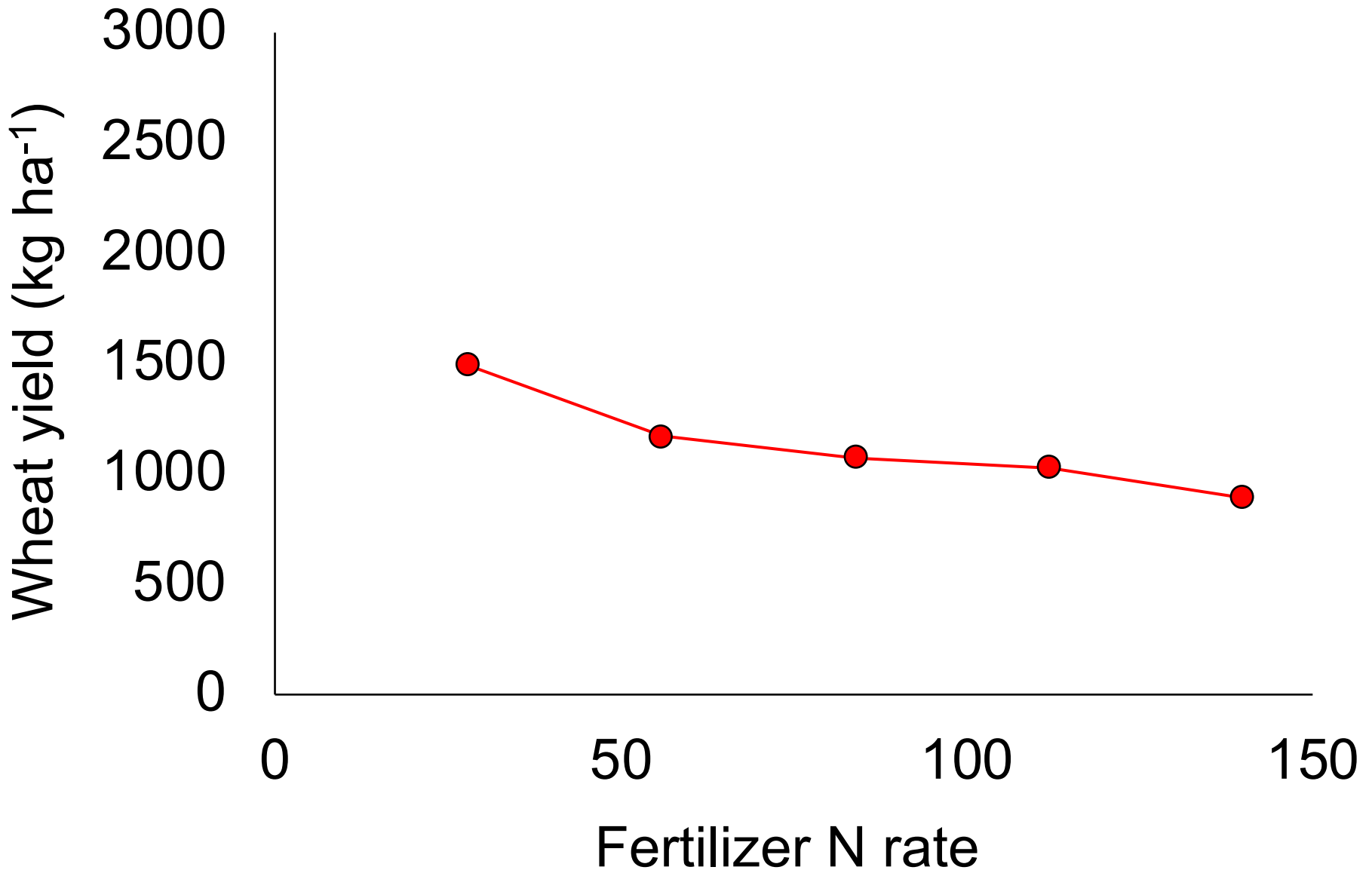
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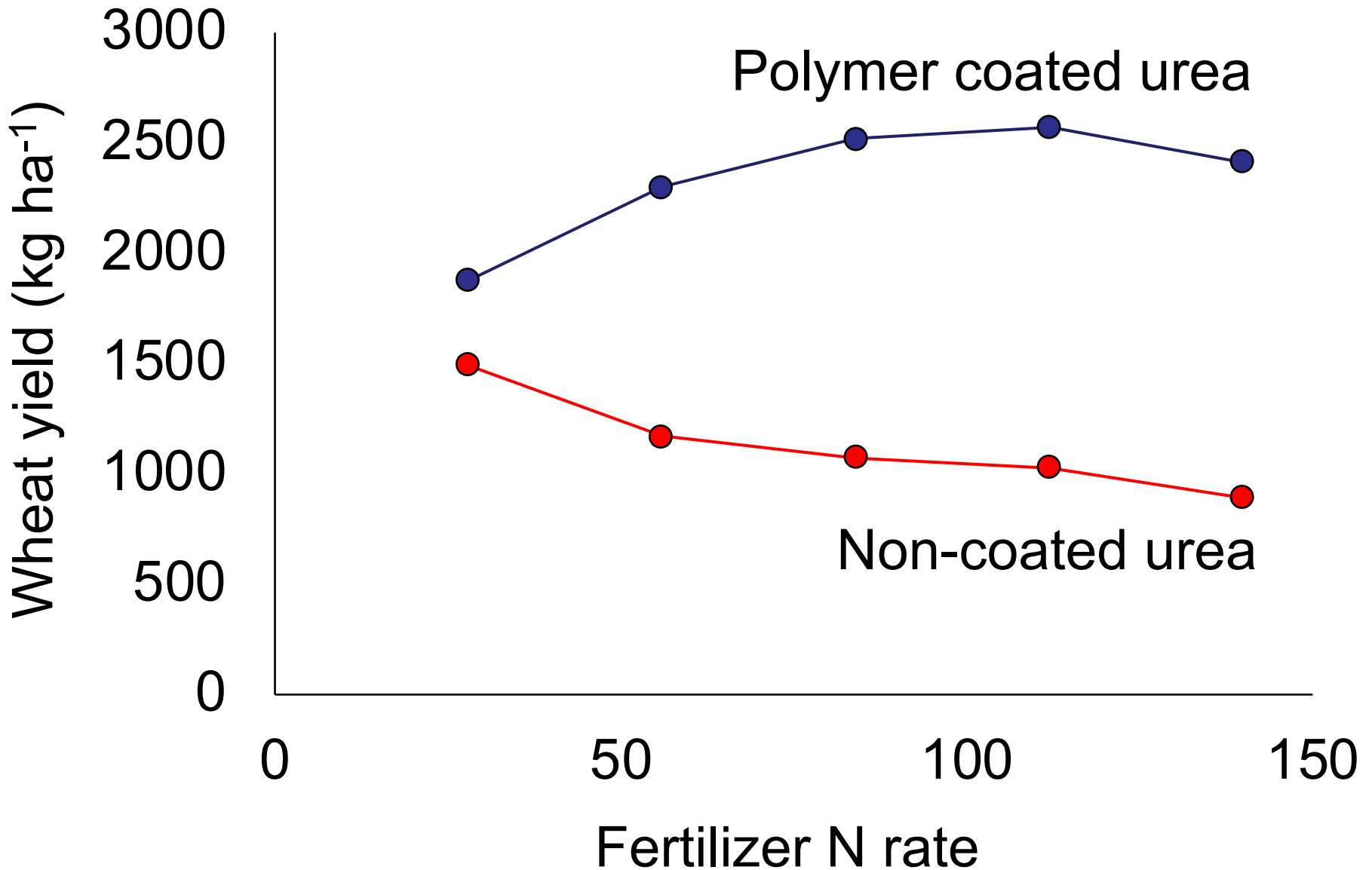
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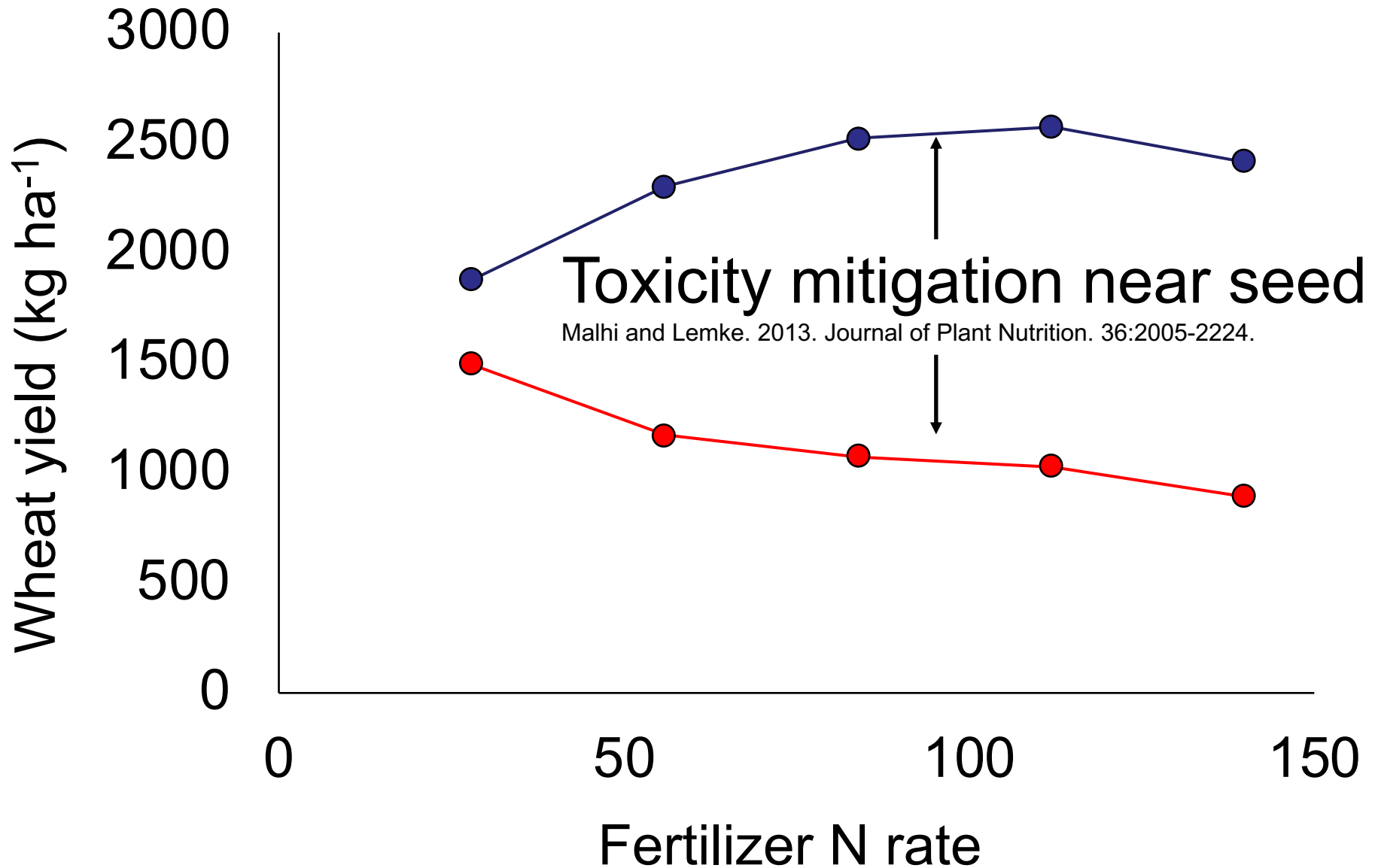
Effects of placement: In the seedrow



Effects of placement: In the seedrow

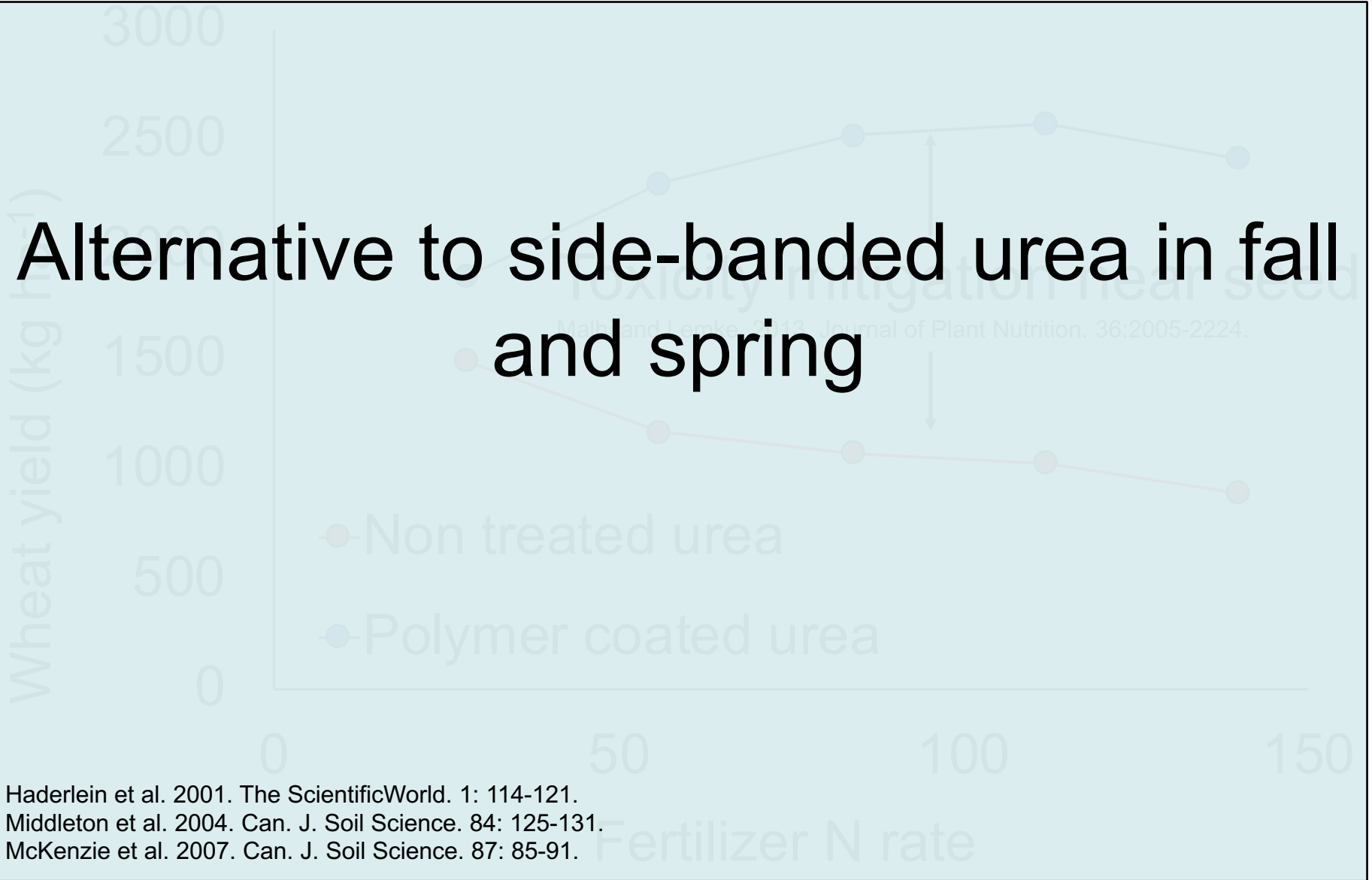


Effects of placement: In the seedrow



Effects of placement: In the seedrow

Alternative to side-banded urea in fall and spring



Haderlein et al. 2001. The ScientificWorld. 1: 114-121.

Middleton et al. 2004. Can. J. Soil Science. 84: 125-131.

McKenzie et al. 2007. Can. J. Soil Science. 87: 85-91.

When polymer coated urea outperforms

Blending of polymer coated urea and non-coated urea may increase grain yield *under high moisture conditions*

Grant et al. 2012. Field Crops Research. 127: 170-180.

Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216.

Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.

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Differences across the topography

Yields (kg ha⁻¹)

Lower Upper

Fall banded urea

2805

2505

Fall banded coated

2900

2660

Spring banded urea

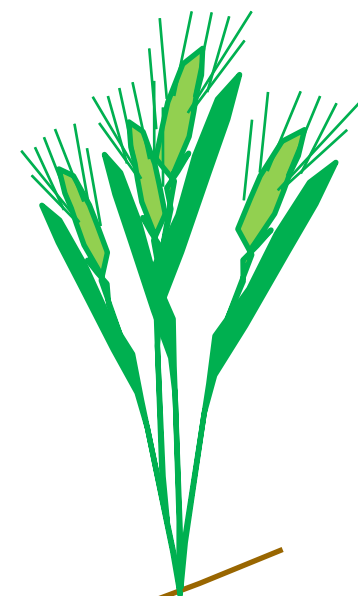
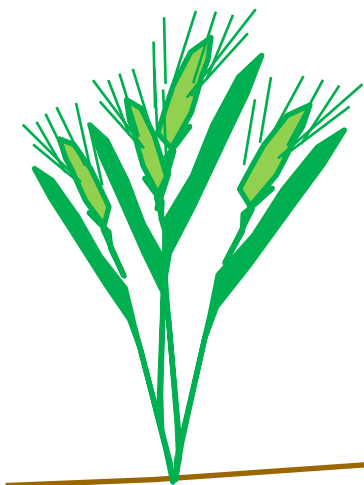
3005

2795

Spring banded coated

2910

2685

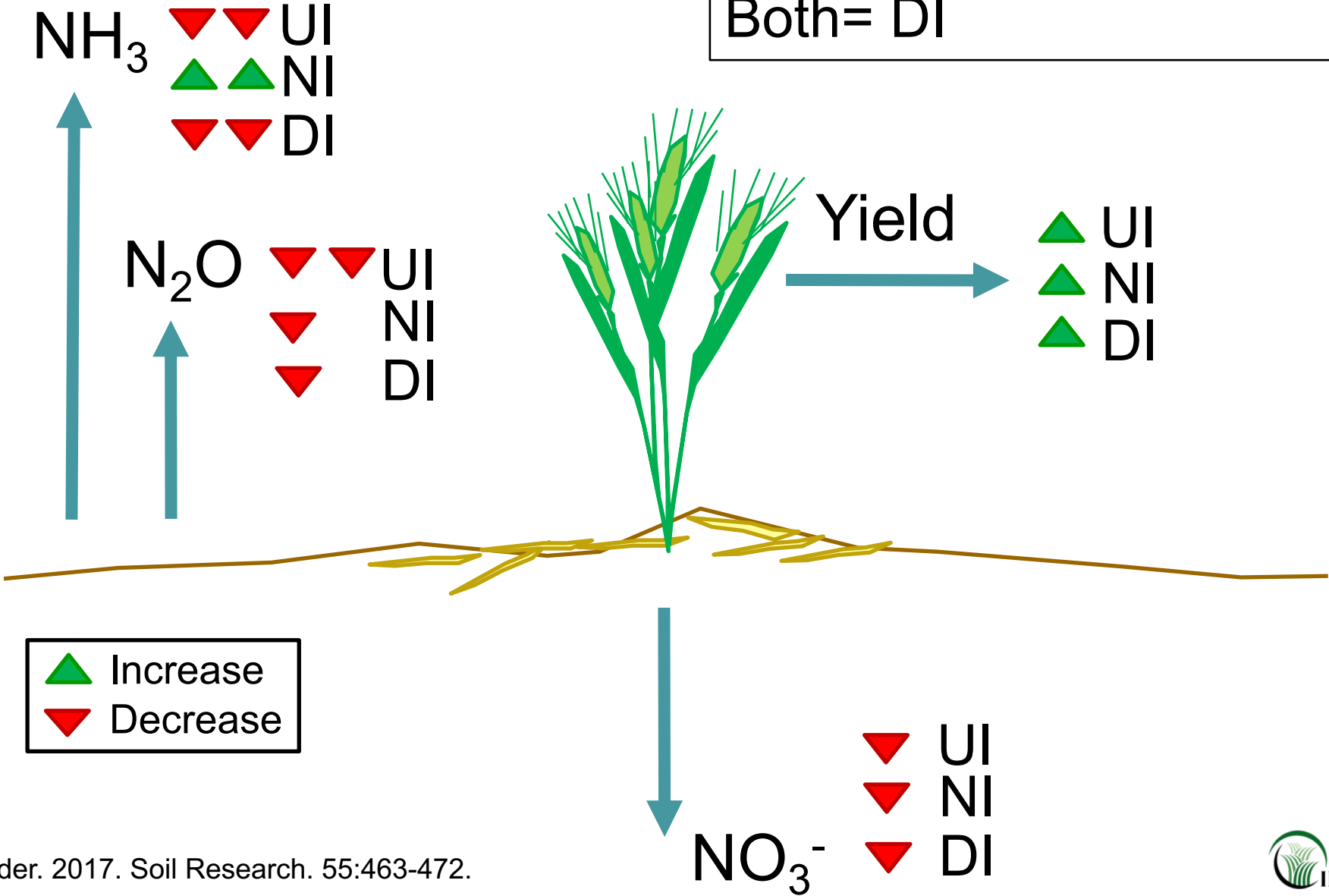


*Mean effect for 2 of 6 site years

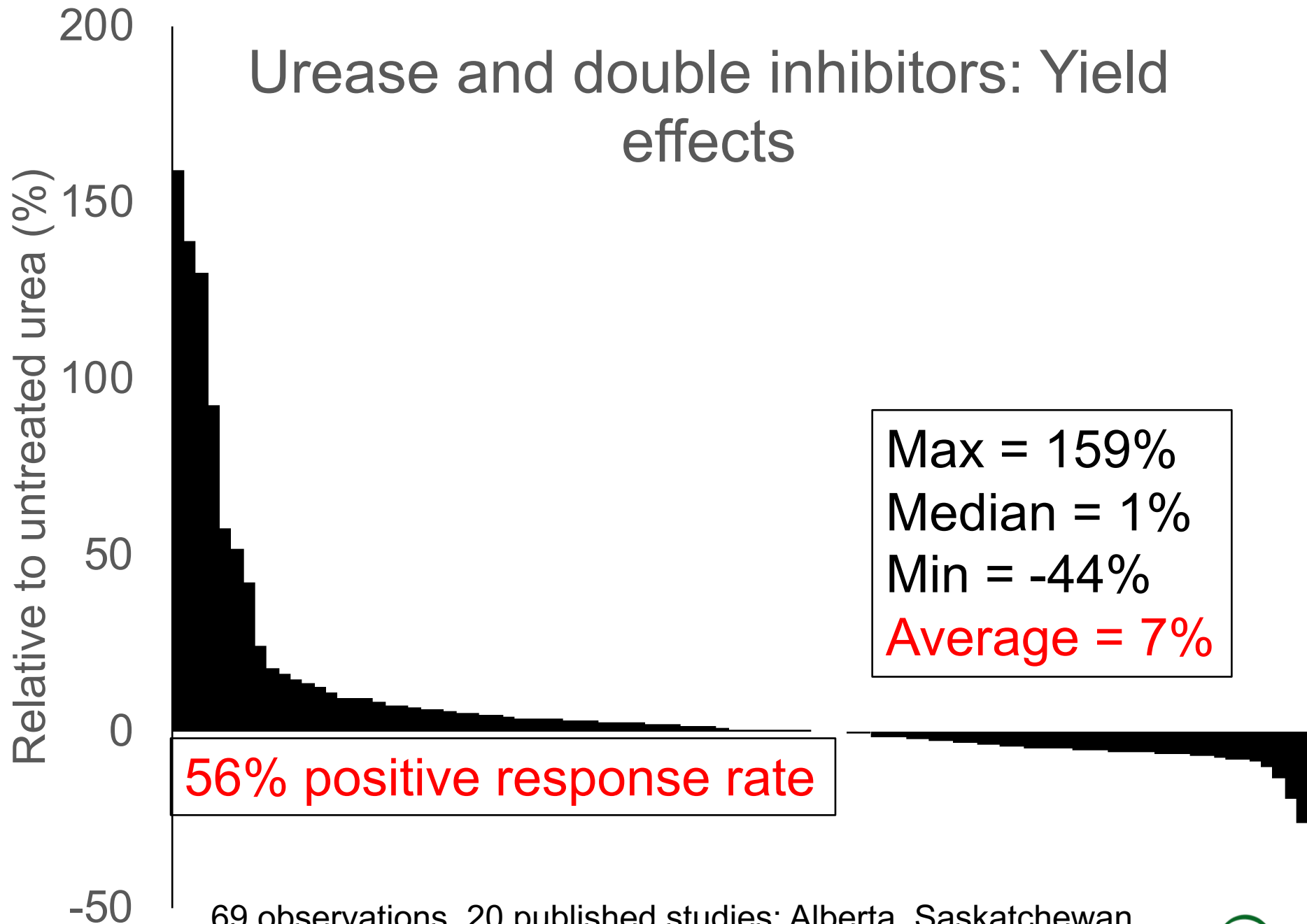
Spring wheat, SW Manitoba: Grant et al. 2016. Agron. J. 1246-1256.

Inhibitors

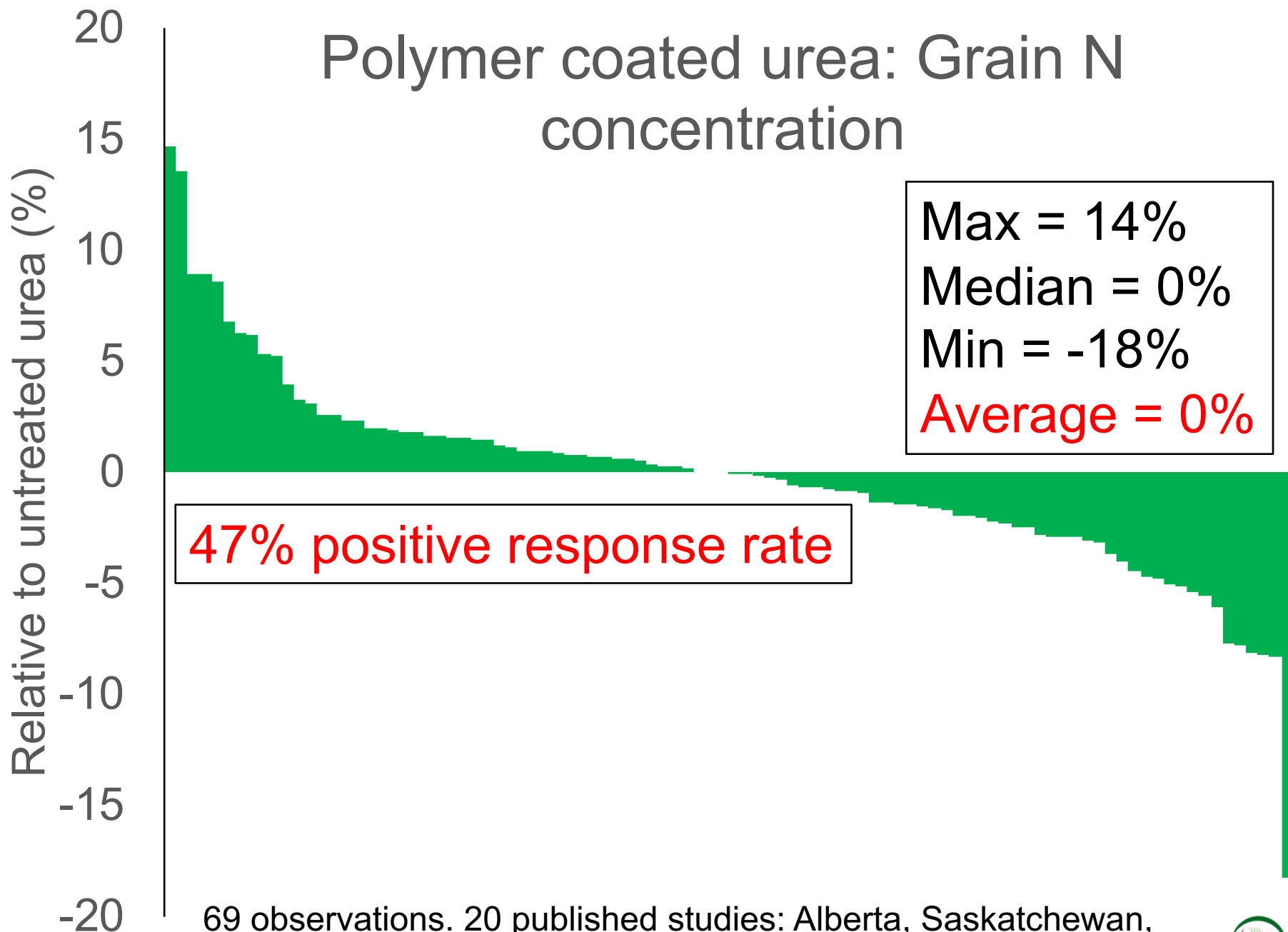
Urease inhibitor = UI
 Nitrification inhibitor = NI
 Both = DI



Urease and double inhibitors: Yield effects

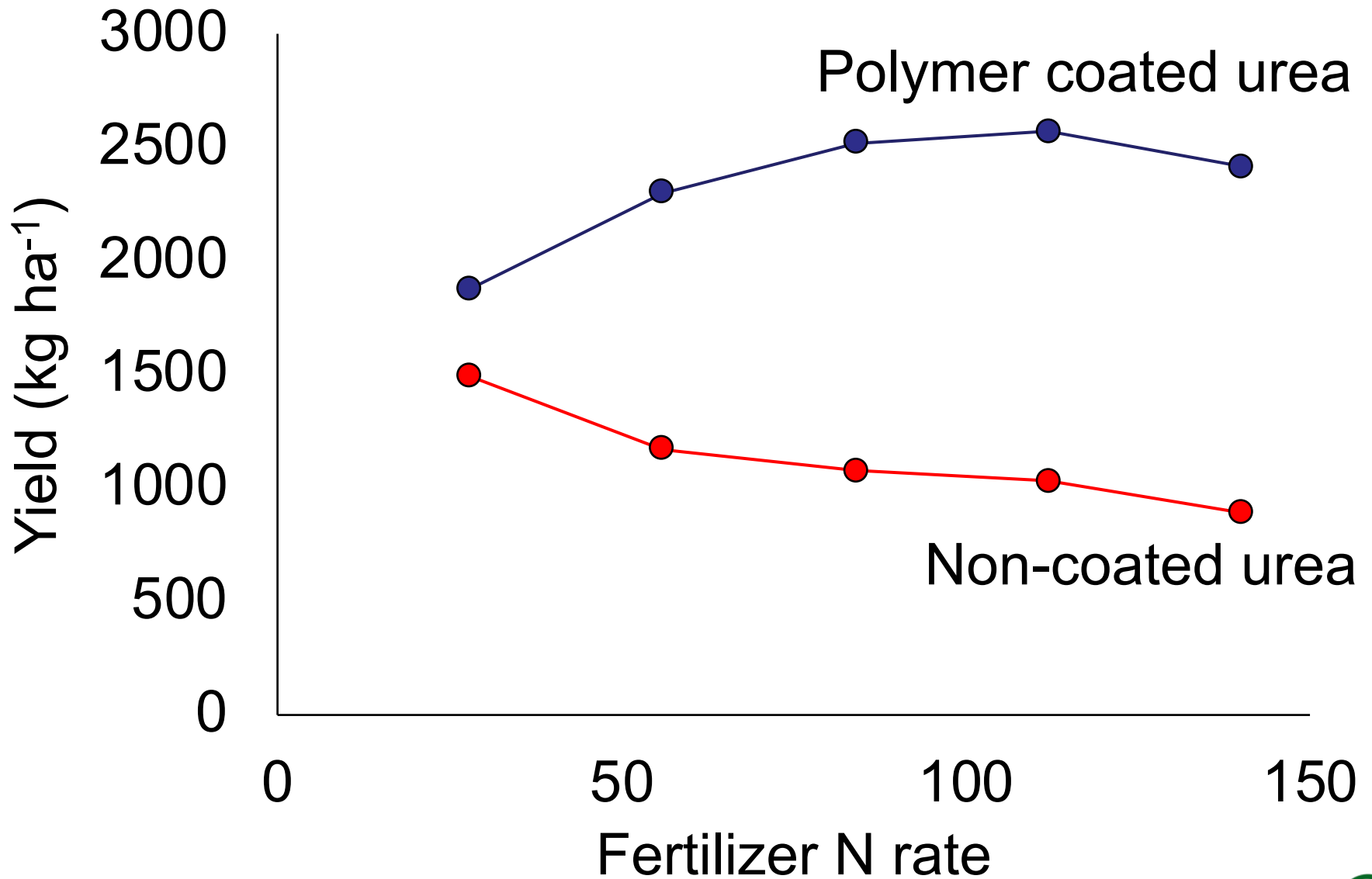


Polymer coated urea: Grain N concentration

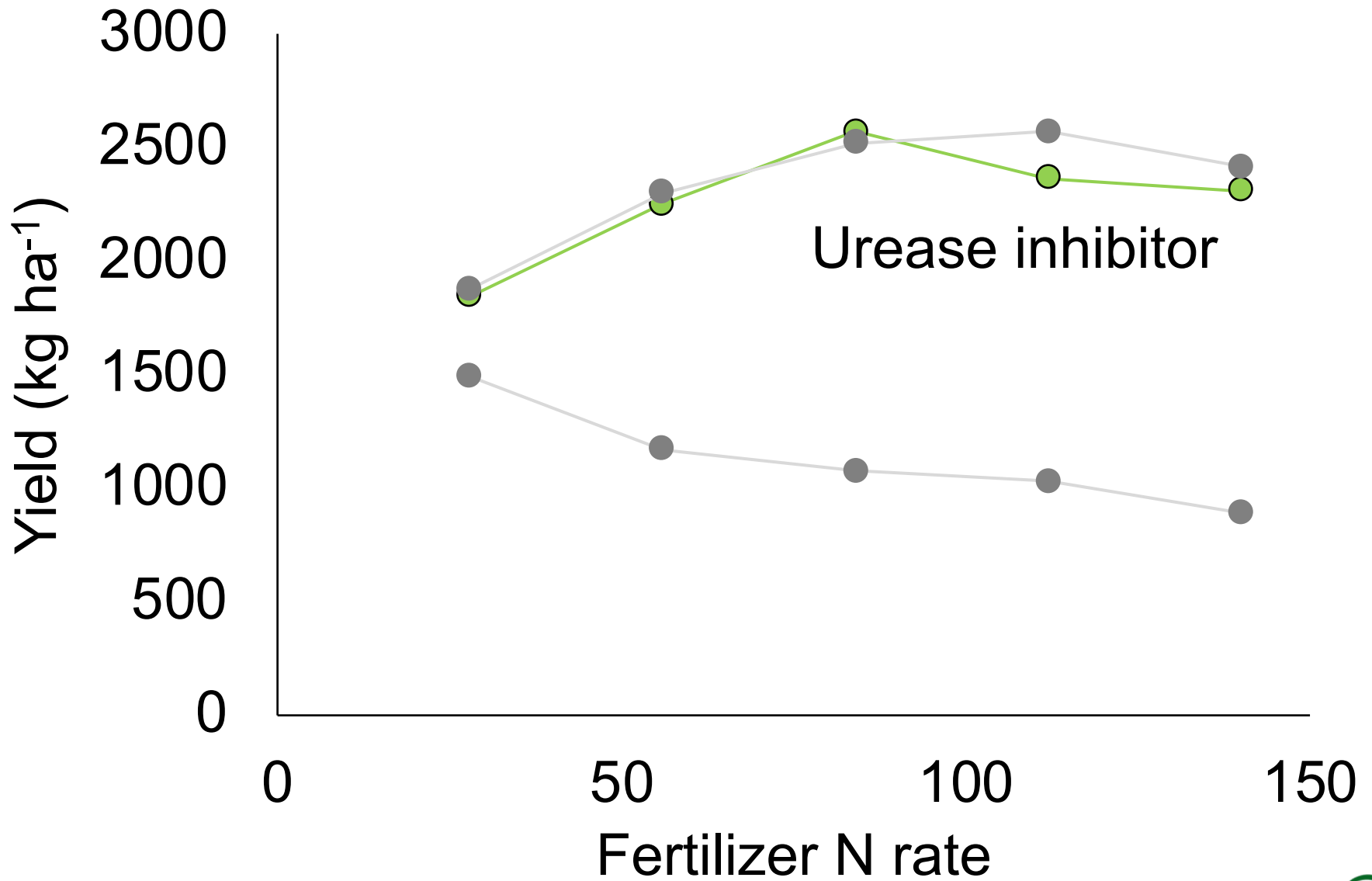


69 observations. 20 published studies: Alberta, Saskatchewan, Manitoba, Montana, South/North Dakota, Nebraska, Minnesota

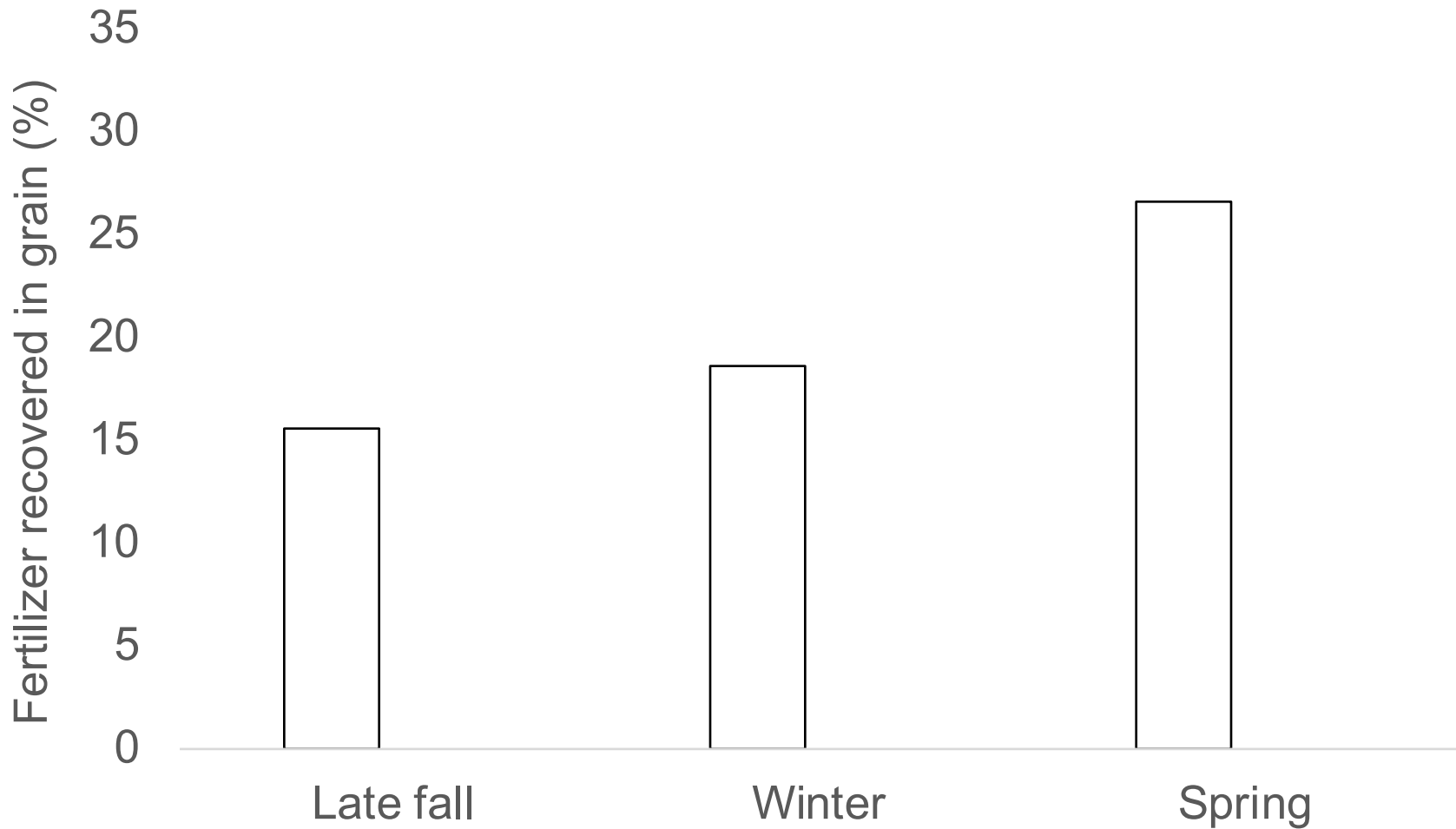
Effects of placement: In the seedrow



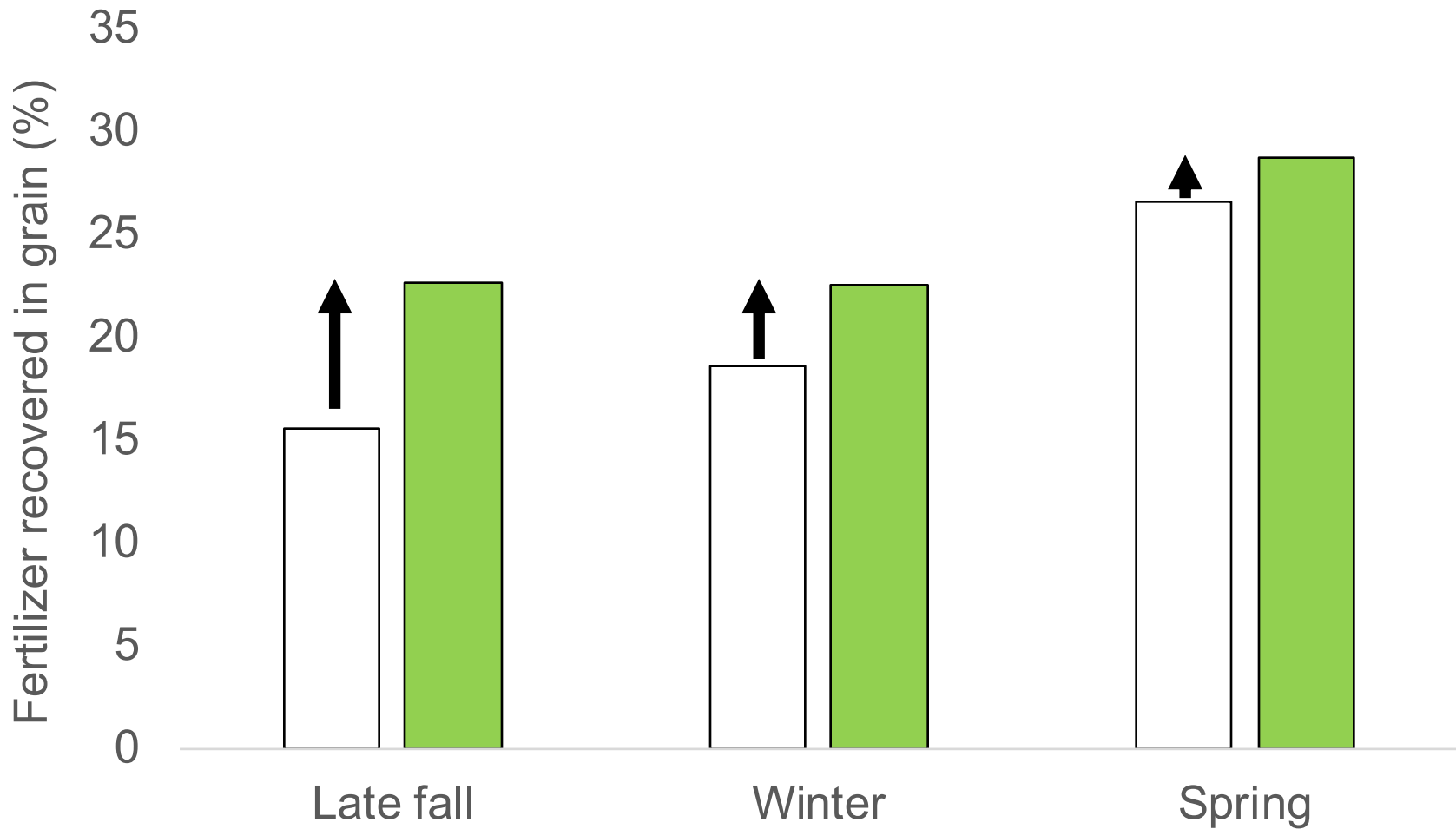
Effects of placement: In the seedrow



Effects of timing: Fall vs Spring



Treating urea with urease inhibitor



Effects of timing: Fall vs Spring

Other studies:

*Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216. *Spring only data

Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.

Forages, Alberta: Karamanos and Stevenson. 2013. Can. J. Plant Sci. 93: 151-160

Effects of timing: Fall vs Spring

Other studies:

Yields increased by **3 to 8%** when treating fall broadcasted urea

*Winter wheat, S. Alberta: McKenzie et al. 2010. Agron. J. 102: 1210-1216. *Spring only data
Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.
Forages, Alberta: Karamanos and Stevenson. 2013. Can. J. Plant Sci. 93: 151-160

Effects of timing: Fall vs Spring

Other studies:

Yields increased by **3 to 8%** when treating fall broadcasted urea

Yields not affected (**0 to -1%**) when treating spring broadcasted urea

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Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.
Forages, Alberta: Karamanos and Stevenson. 2013. Can. J. Plant Sci. 93: 151-160

Combining urease and nitrification inhibitors

Yield relative to
non-treated urea

Urease inhibitor

-1 to -7%

Winter wheat, Montana: Mohammed et al. 2016. Agron. J. 108: 905-912.
Winter wheat, Beiseker, Alberta: Jensen. 2007. Personal communication.
Forage, Youngstown, Alberta: Jensen, 2012. Personal communication.

Effect of combining with a nitrification inhibitor

Yield relative to
non-treated urea

Urease inhibitor

-1 to -7%

Double inhibitor

5 to 29%

Summary

- Consider modes of action [1]

Summary

- Consider modes of action [1]
- Consider timing and placement

Summary

- Consider modes of action [1]
- Consider timing and placement
 - Seed row placement
 - Fall application with high loss risk
 - Blending source in spring

Summary

- Consider modes of action [1]
- Variable effects on yields
 - Seed row placement
 - Fall application with high loss risk
 - Blending source in spring
- Combining urease and nitrification inhibitors provide multiple modes of actions



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Thank you

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