Phosphorus Management Considerations for Southern Saskatchewan

Agri-Arm Research Update

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Introduction

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Low STP: Soil P depletion. Potential cap on yield.

High STP: Potential for water quality degradation.

Careful P management needed!

Introduction

4R Nutrient Stewardship is an effective framework for the implementation of agricultural Best Management Practices (BMPs).

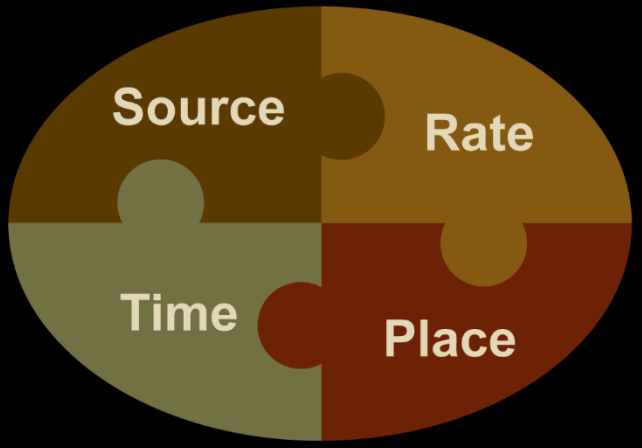


Photo Credit: www.ipni.net

What is influence of rate and method of placement of P fertilizer?

Study 1: Safe Rates of Seed-Placed and Side-Banded Phosphorus in Canola.

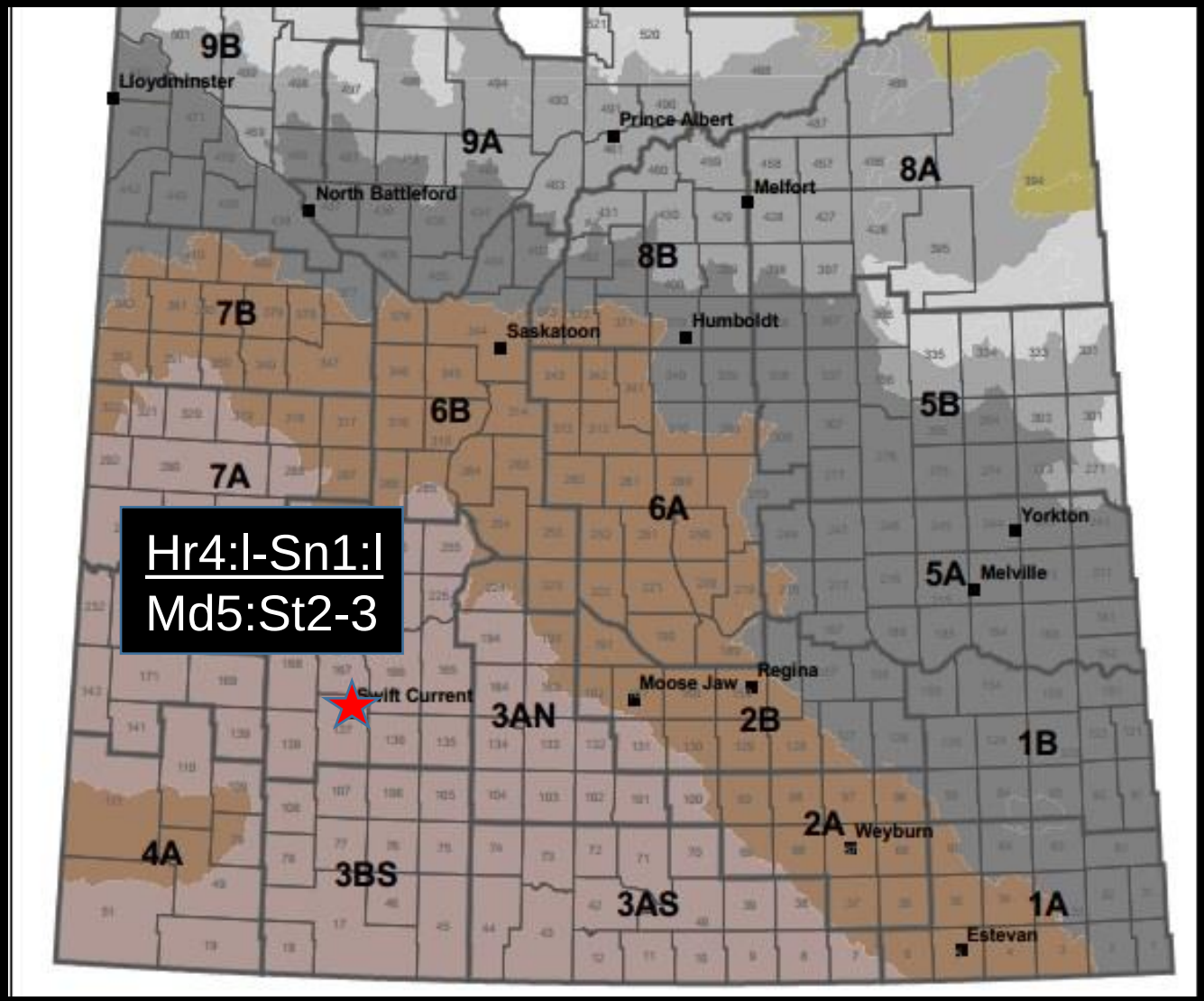
Introduction

Table 1. Balance between seed-placed P addition and P removal for various crops grown on the Canadian prairies.

Crop	Yield (kg ha^{-1})	Seed Placed Limit (kg ha^{-1})	Removal (kg ha^{-1})	Net Effect (kg ha^{-1})
Soybean	2695	11.2	35.8	-24.6
Canola	2695	22.4	44.8	-22.4
Wheat	2695	56	32.5	+23.5

Adapted from Grant (2012).

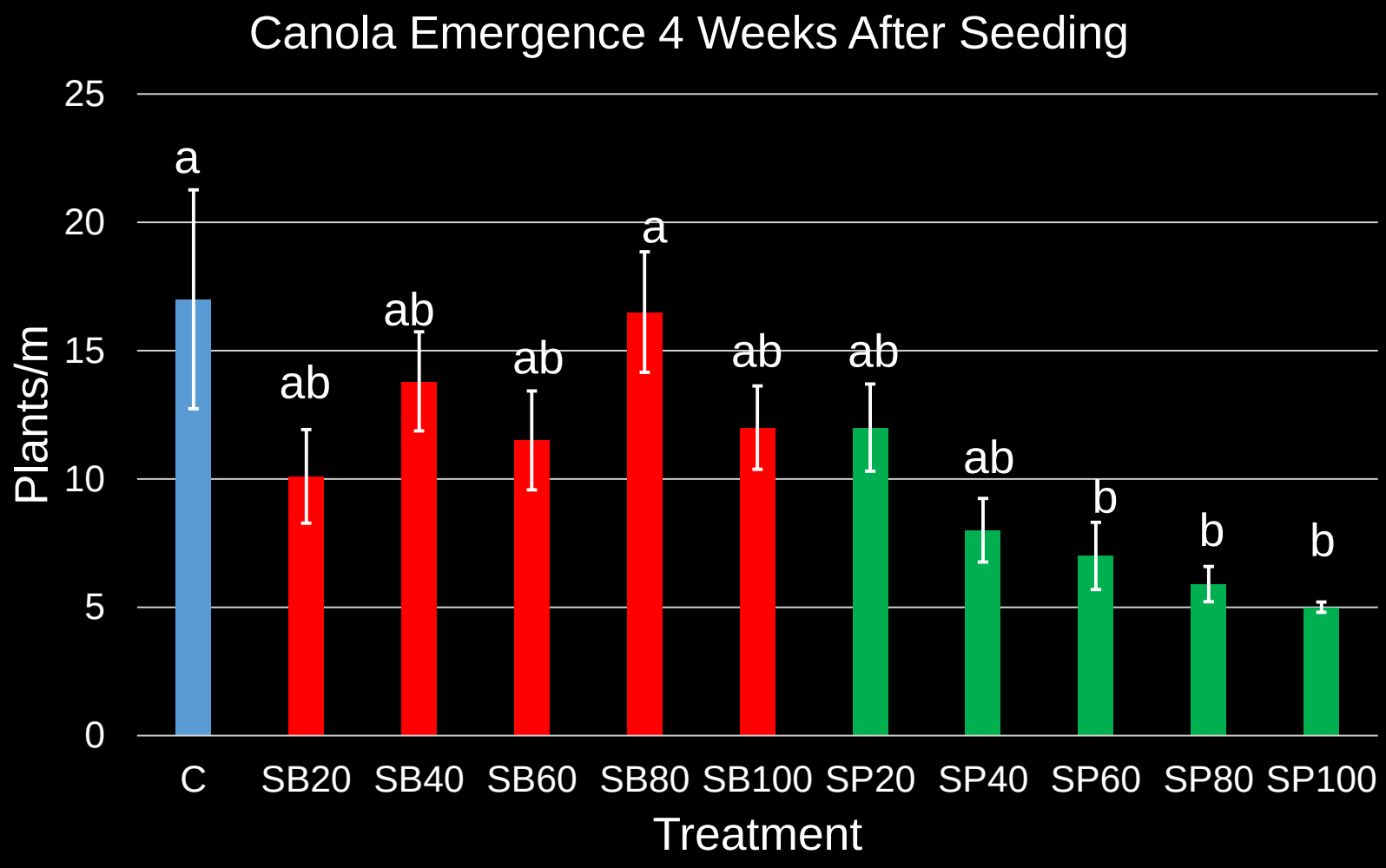
Site Description



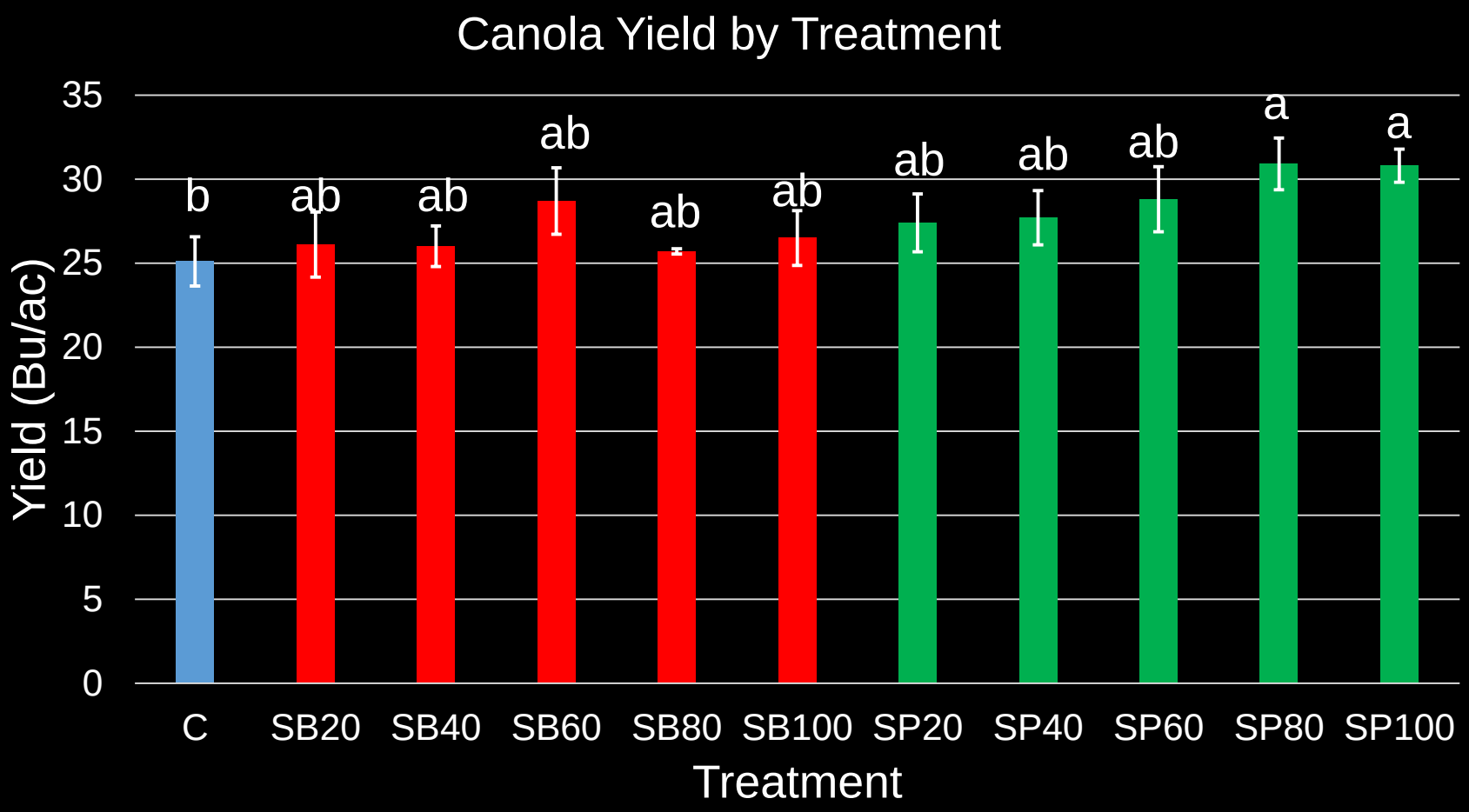
Treatments

1) Control
2) Side-Band P at 20 kg P_2O_5 ha^{-1}.
3) Side-Band P at 40 kg P_2O_5 ha^{-1}.
4) Side-Band P at 60 kg P_2O_5 ha^{-1}.
5) Side-Band P at 80 kg P_2O_5 ha^{-1}.
6) Side-Band P at 100 kg P_2O_5 ha^{-1}.
7) Seed-Placed P at 20 kg P_2O_5 ha^{-1}.
8) Seed-Placed P at 40 kg P_2O_5 ha^{-1}.
9) Seed-Placed P at 60 kg P_2O_5 ha^{-1}.
10) Seed-Placed P at 80 kg P_2O_5 ha^{-1}.
11) Seed-Placed P at 100 kg P_2O_5 ha^{-1}.

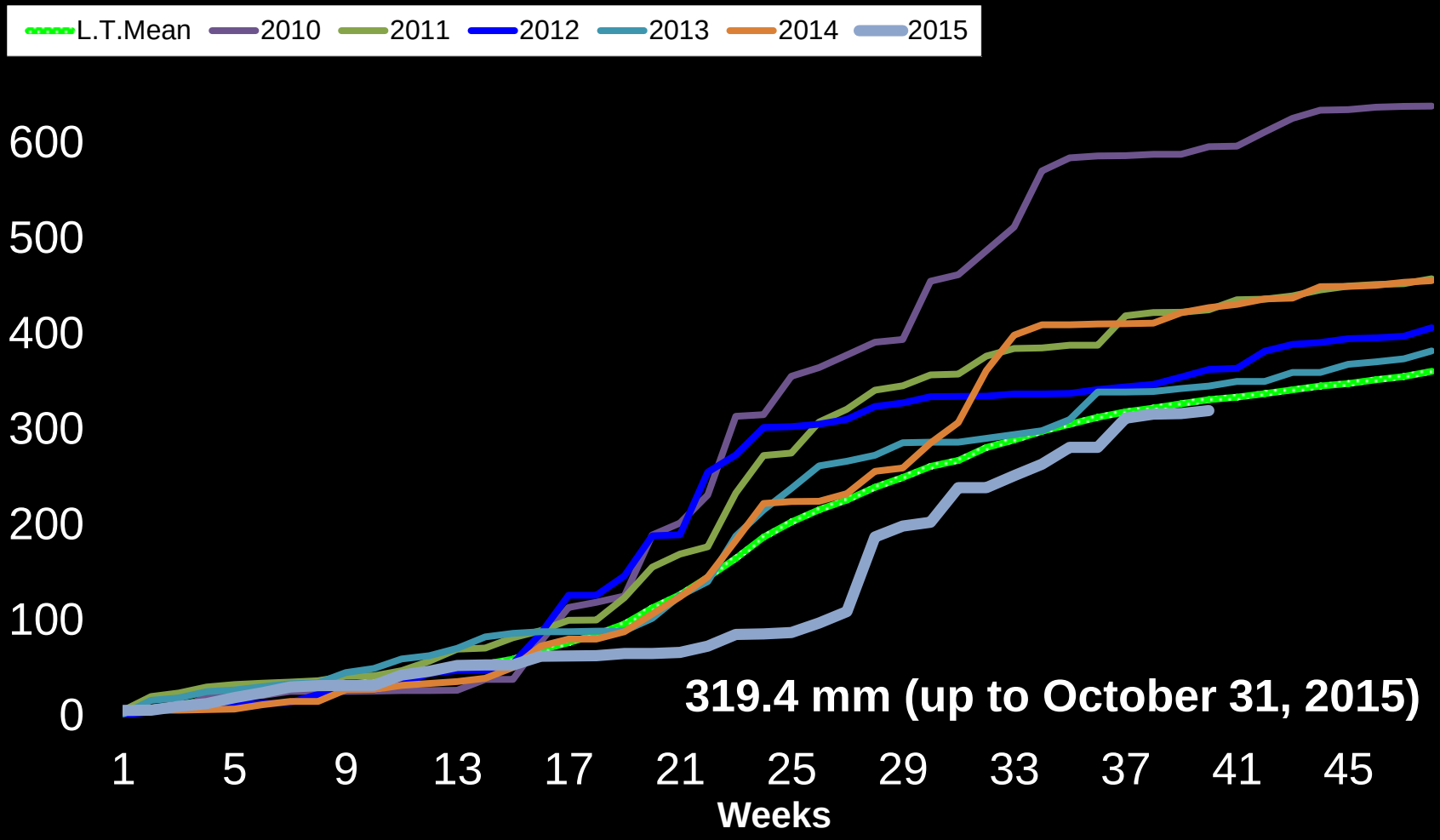
Results: Emergence



Results: Yield



2015 Cumulative Precipitation



Discussion

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But, by crop harvest, canola had a slight yield response to highest rates of Seed-placed P. Why?

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But, by crop harvest, canola had a slight yield response to highest rates of Seed-placed P. Why?

Dry weather conditions in spring and early summer may explain.

Discussion (Continued)

P mainly moves by diffusion in soil. P transport in cold, dry soils is severely inhibited.

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Under dry conditions, P in Side Band treatments may have been placed too far from seed to be available for crop uptake.

Discussion (Continued)

In general, Seed-placed treatments performed better than Side Band treatments.

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Under 2015 conditions, only a high rate of Seed-Placed P was able to achieve a yield response, even in P deficient soils.

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P uptake by canola proceeds throughout the entire growing season. Research has shown that by harvest, 41% of total P uptake is from fertilizer P (Johnston, 2003).

Conclusions

Effect that high rates of seed-placed P had on canola emergence is in agreement with current recommendations.

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Conclusions on the effect that reduced canola emergence has on grain yield cannot be made based on poor growing season conditions.

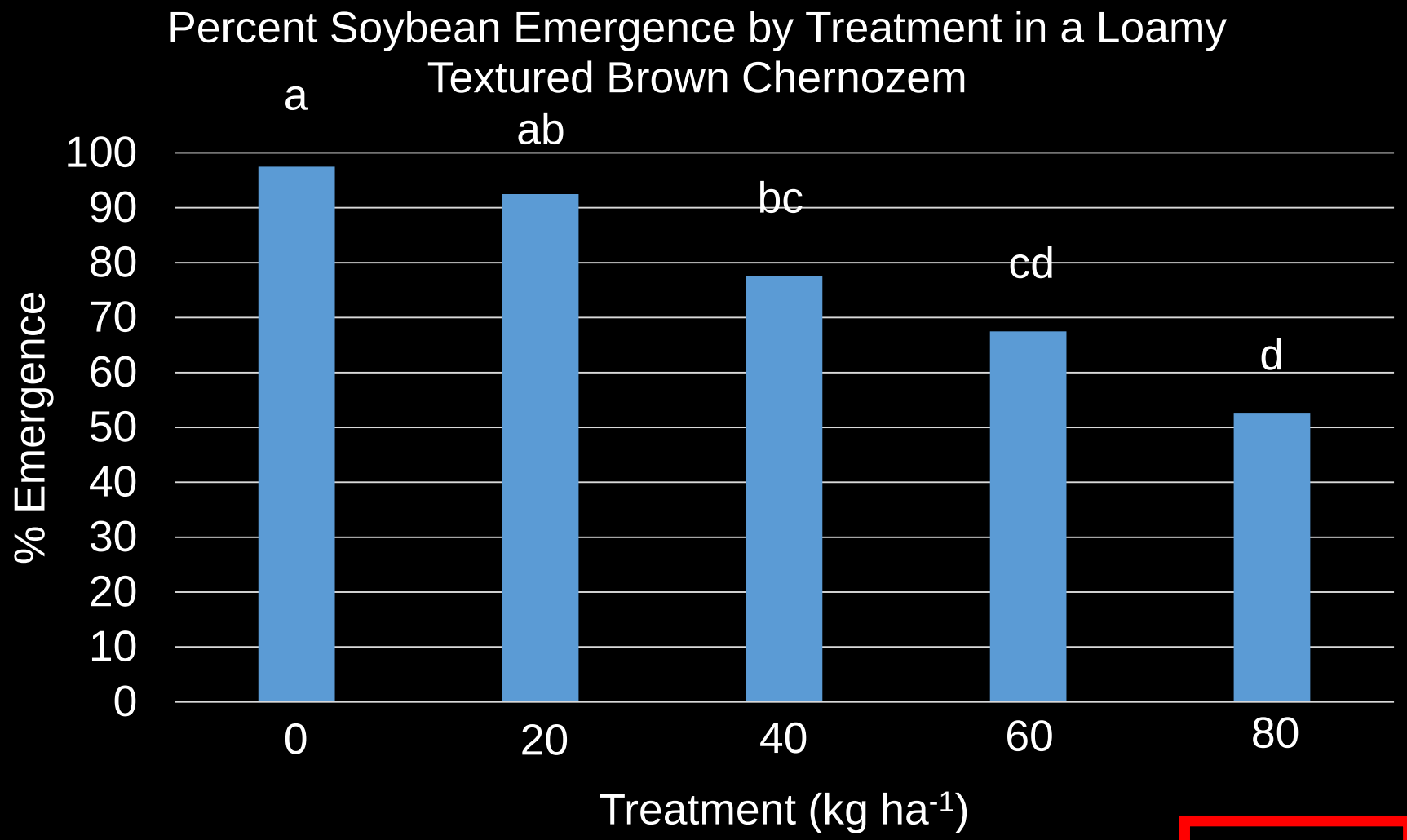
Study 2: Effect of Varying Rates of Seed-Placed Fertilizer P on Soybean Seedling Emergence and Biomass Yield.

Crop in My Studies: Soybeans

Why Soybeans?

- Emerging crop in Saskatchewan.
- Little information on response of short-season soybean to P fertilization on prairies.

Soybean Results



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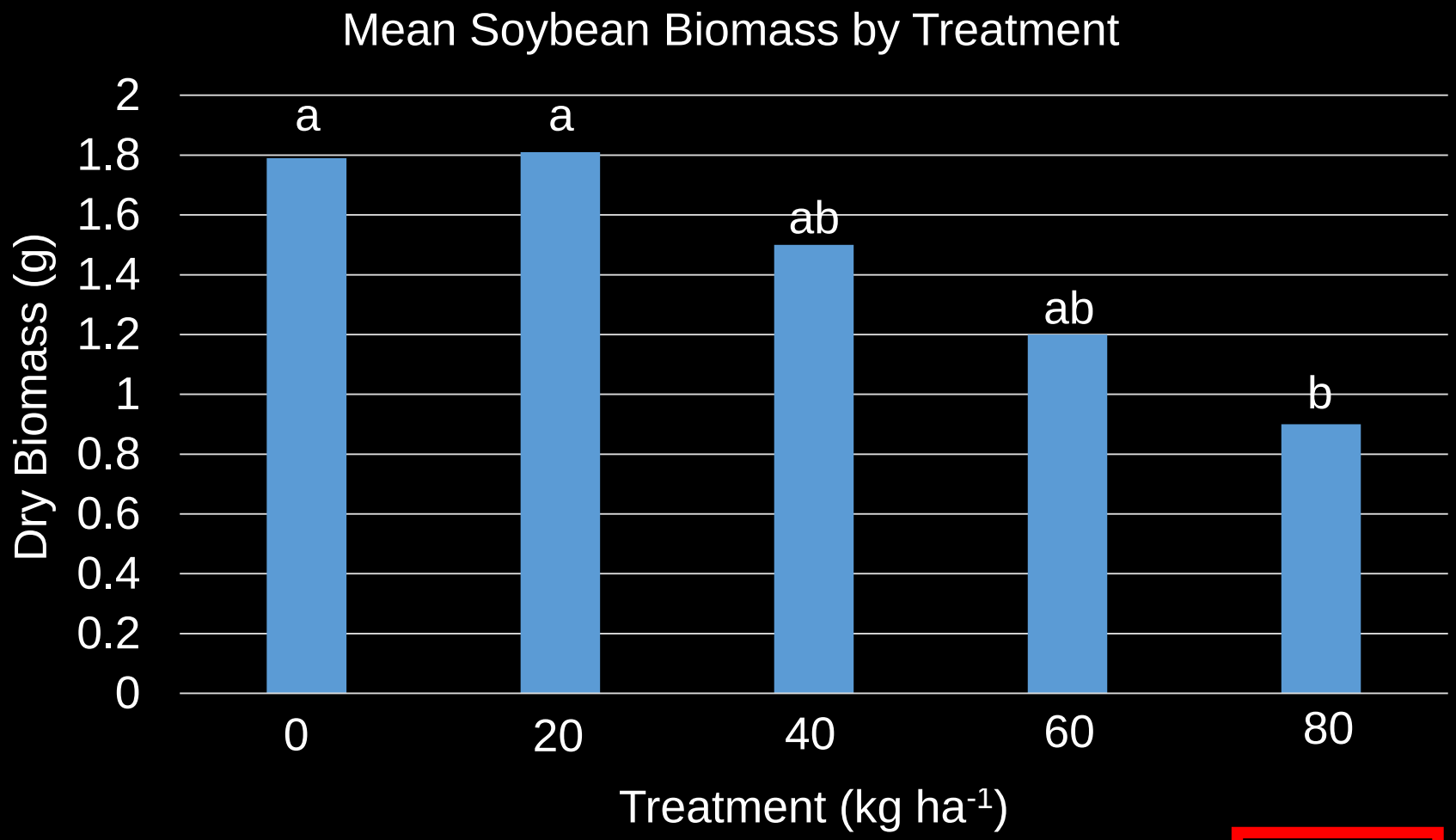

P=0.002

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- Kostuik found that fertilizer P application at 40 kg P_2O_5 ha^{-1} did not negatively affect soybean biomass production or grain yield.

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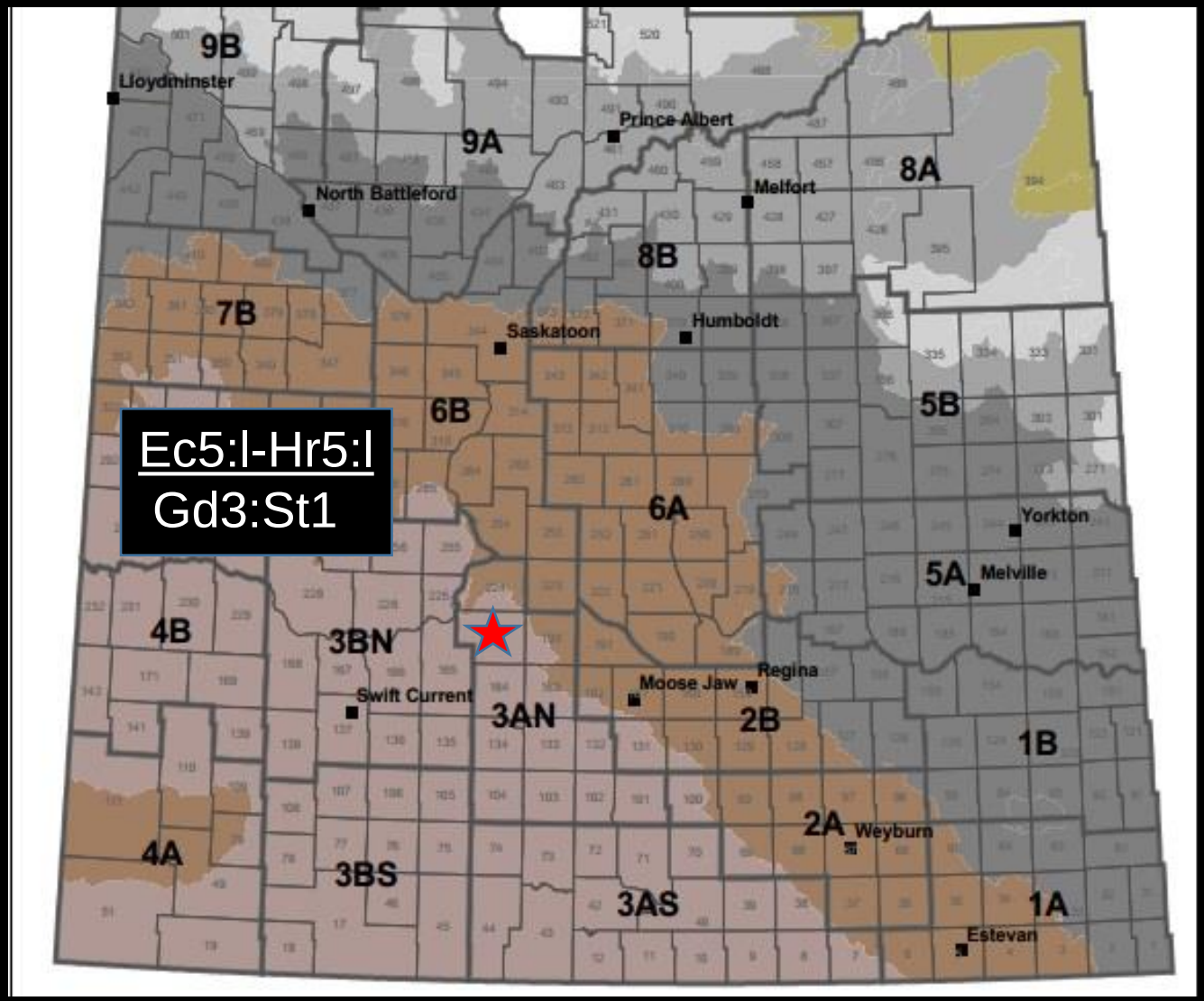
Kostuik found that fertilizer P application at 40 kg P_2O_5 ha^{-1} did not negatively affect soybean biomass production or grain yield.

At least 20 kg P_2O_5 ha^{-1} can be safely seed-placed with soybean. Helps P balance.

Study 3: A Field Study of the Effect of Fertilizer P Application on Soybean Yield and Residual Soil P Distribution.

Site Description

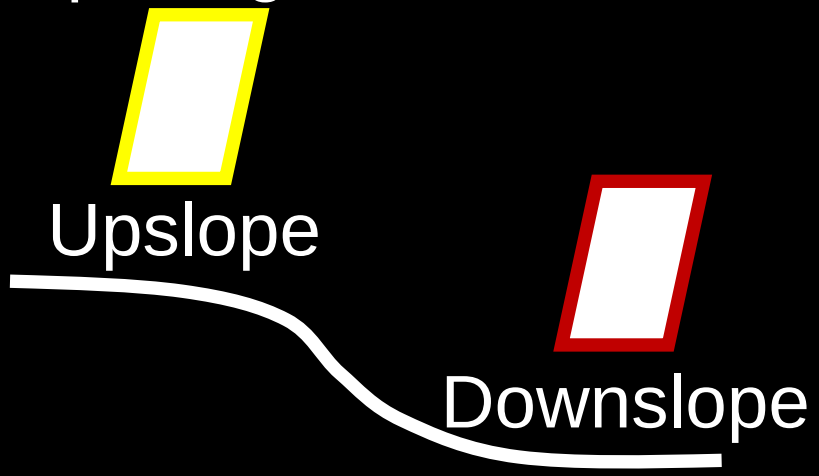


Experimental Design

Two sites representing contrasting slope positions in the same field were chosen.

Experiment conducted as a Randomized Complete Block Design with four replicates.

Soybean (NSC Moosomin) seeded at 25 cm row spacing for 3 rows in a 3 x 1m plot.



Treatments

C 1) No P fertilizer

SP 2) Seed placed P at 20 kg P_2O_5 ha^{-1}

DB 3) Banded P below seed at 20 kg P_2O_5 ha^{-1}

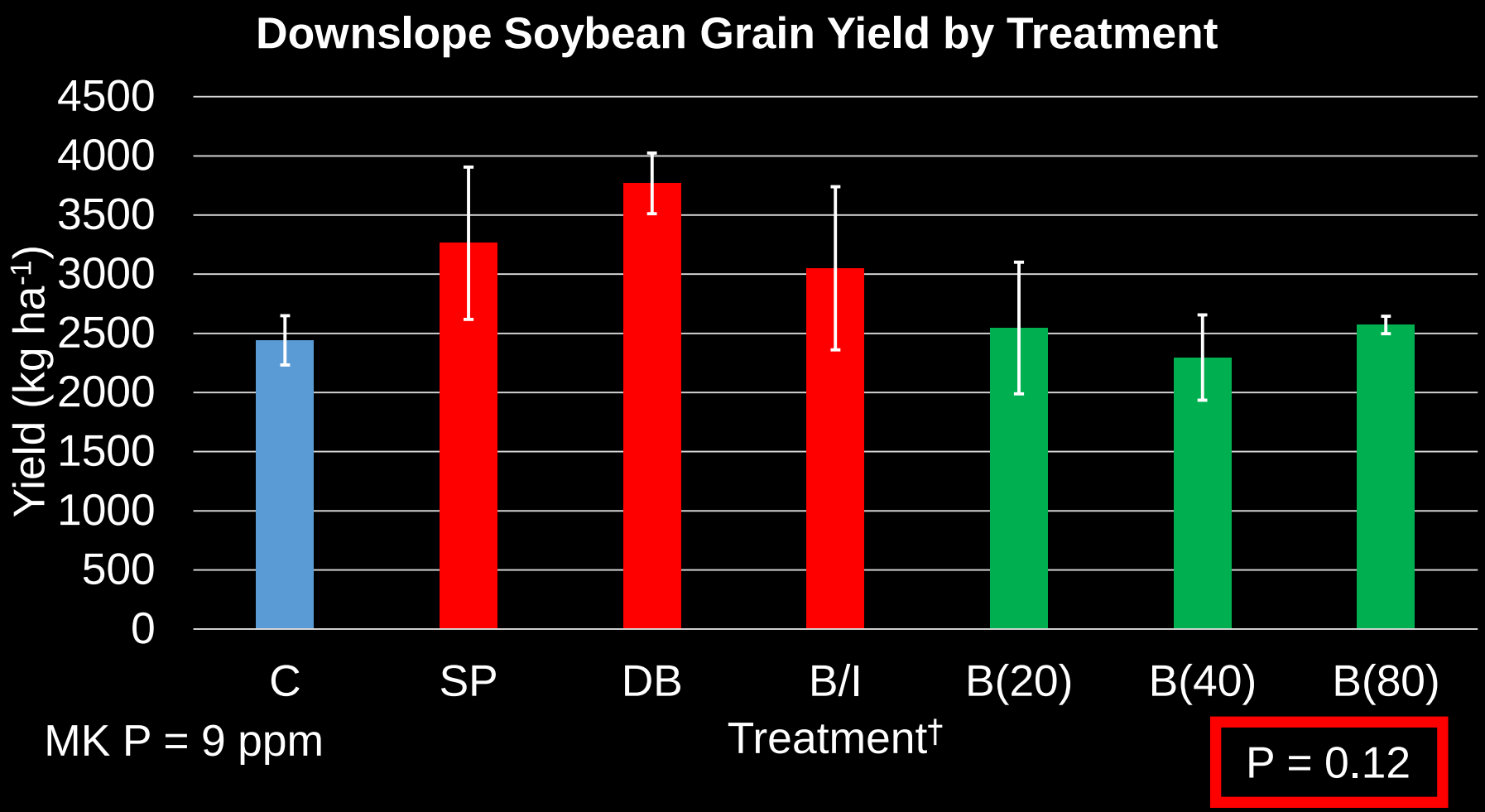
B/I 4) Broadcast P at 20 kg P_2O_5 ha^{-1} with incorporation;

B(20) 5) Broadcast P at 20 kg P_2O_5 ha^{-1} without incorporation;

B(40) 6) Broadcast P at 40 kg P_2O_5 ha^{-1} without incorporation; and

B(80) 7) Broadcast P at 80 kg P_2O_5 ha^{-1} without incorporation.

Results



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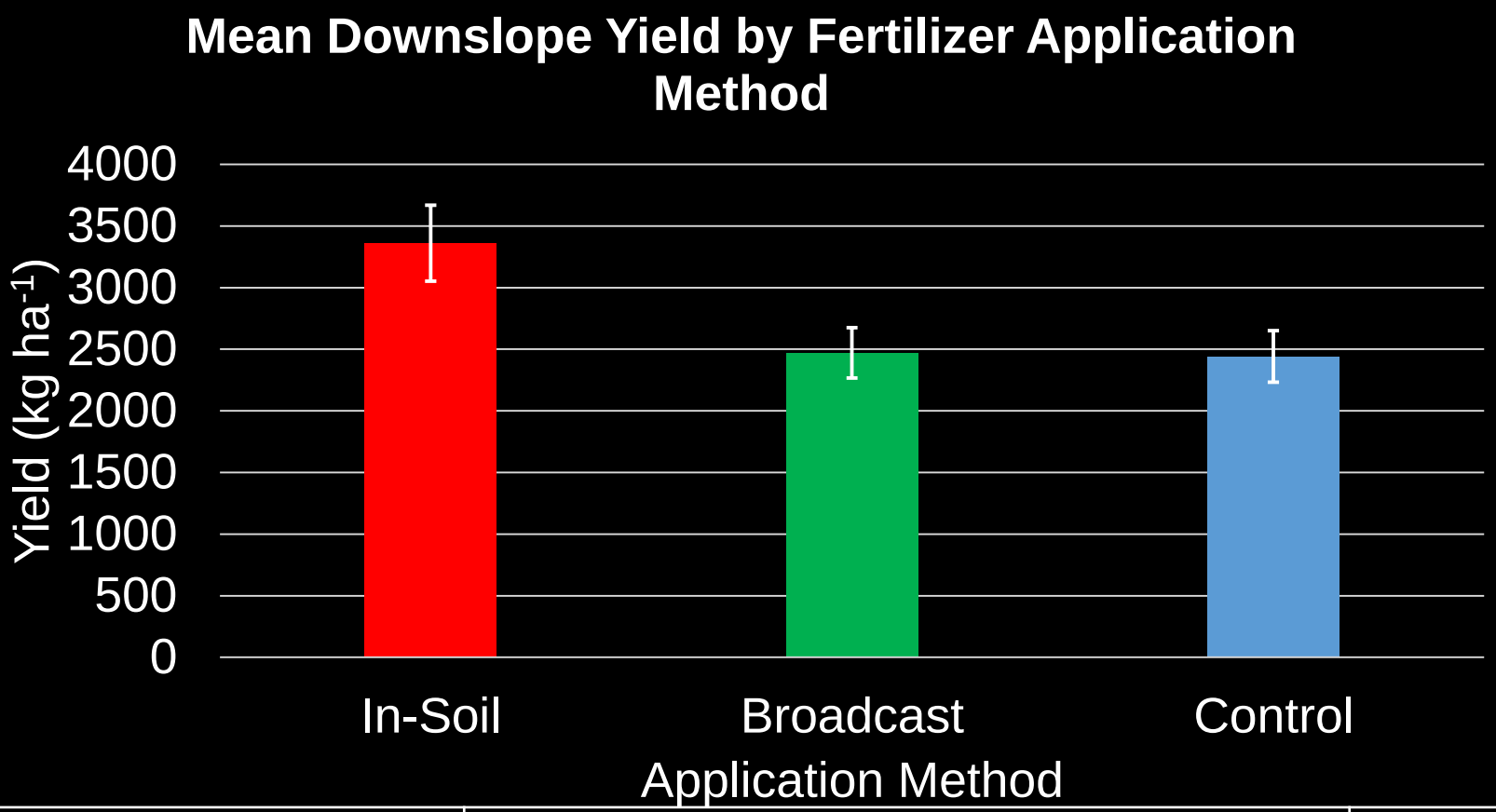

Orthogonal Contrasts	Treatments† Compared	P Value
In-Soil vs. Broadcast	SP, DB, B/I vs. B(20), B(40), B(80)	0.0096
Control vs. In-Soil	C vs. SP, DB, B/I	0.0488
Control vs. Broadcast	C vs. B(20), B(40), B(80)	0.9479

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Results

Parameter	Treatment							*P* Value
	C	SP	DB	B/I	B(20)	B(40)	B(80)	
Grain Yield (kg ha^{-1})	2442^{a}	3262^{a}	3768^{a}	3050^{a}	2545^{a}	2295^{a}	2571^{a}	0.12
Grain P Uptake (kg ha^{-1})	11.3a	16.4a	17.7a	12.5a	11.6a	11.0a	13.1a	0.08
Plant P Recovery (%)	-	25.0	31.0	1.5	1.0	-0.3	2.3	-

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Soybean yield response to seed-placed, banded P in downslope.

In-soil P placement superior to broadcast.

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Soybean yield responsive to P fertilization when STP was < 19 mg kg^{-1} (Bray P_i) (Borges and Mallarino, 2003).

Banded P resulted in increased soybean yield compared to broadcast application (Hairston et al., 1990).

Discussion (Cont.)

Seed-placed and deep banded fertilizer P application resulted in greater grain P uptake and recovery of applied P compared to broadcast treatments.

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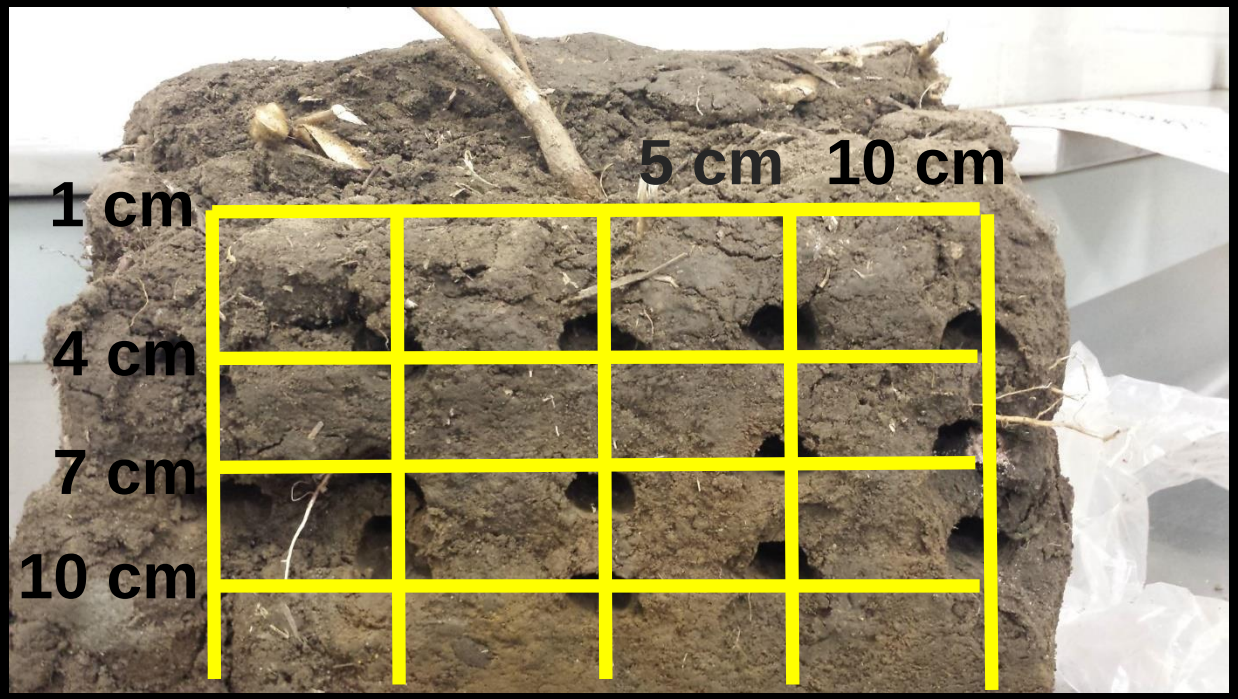
Broadcast application of fertilizer P at elevated rates resulted in greater STP values measured at the soil surface (0-5 cm) relative to in-soil application.

Soil Sampling for Soil Phosphorus Recommendations

Subsampling of monoliths, and Modified Kelowna-P extraction to characterize.



	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	13.4	12.8	9.8	11.2	17.4
4 cm	5.7	5.9	4.3	4.1	4.6
7 cm	1.4	1.5	1.6	1.4	1.7
10 cm	1.4	1.3	1.5	1.4	1.8

Control (No P Fert)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	5.3	8.5	20.7	12.8	9.6
4 cm	3.4	6.5	13.0	9.2	5.6
7 cm	1.6	2.1	2.0	3.0	2.2
10 cm	1.1	1.6	2.4	2.7	2.0

Seed Placed (20 kg P_2O_5/ha)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	13.4	12.8	9.8	11.2	17.4
4 cm	5.7	5.9	4.3	4.1	4.6
7 cm	1.4	1.5	1.6	1.4	1.7
10 cm	1.4	1.3	1.5	1.4	1.8

Control (No P Fert)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	10.8	13.8	12.9	13.9	11.6
4 cm	8.5	8.8	11.1	7.0	16.4
7 cm	1.7	14.8	4.3	4.4	6.0
10 cm	1.4	11.4	1.3	1.5	1.7

Deep Band (20 kg P_2O_5/ha)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	13.4	12.8	9.8	11.2	17.4
4 cm	5.7	5.9	4.3	4.1	4.6
7 cm	1.4	1.5	1.6	1.4	1.7
10 cm	1.4	1.3	1.5	1.4	1.8

Control (No P Fert)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	12.2	16.4	13.8	27.6	8.9
4 cm	7.7	15.2	9.4	18.3	8.1
7 cm	3.4	3.5	1.7	3.1	2.2
10 cm	1.8	1.7	1.5	1.9	1.6

Broadcast (20 kg P_2O_5/ha)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	13.4	12.8	9.8	11.2	17.4
4 cm	5.7	5.9	4.3	4.1	4.6
7 cm	1.4	1.5	1.6	1.4	1.7
10 cm	1.4	1.3	1.5	1.4	1.8

Control (No P Fert)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	14.5	15.6	12.0	10.8	
4 cm	5.7	8.3	8.6	6.8	12.6
7 cm	2.0	2.9	3.9	5.8	10.2
10 cm	1.9	2.2	1.9	2.0	1.8

Broadcast with Incorporation (20 kg P_2O_5/ha)

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	13.4	12.8	9.8	11.2	17.4
4 cm	5.7	5.9	4.3	4.1	4.6
7 cm	1.4	1.5	1.6	1.4	1.7
10 cm	1.4	1.3	1.5	1.4	1.8

Control

	10 cm	5 cm	Seed-row	5 cm	10 cm
1 cm	21.8	23.4	14.7	45.4	21.5
4 cm	14.4	18.1	16.2	14.3	12.5
7 cm	2.8	1.9	1.7	1.9	1.4
10 cm	2.0	1.5	1.5	1.5	1.8

Broadcast (40 kg P_2O_5/ha)

Summary of Results

Fertilizer application method was found to influence P distribution in soil profile after harvest.

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- Broadcast application of fertilizer P resulted in P stratification near the soil surface.
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Considerable micro-scale variability in soil test P concentrations. This agrees with previously conducted research in no-till fields (Hu et al., 2014).

Implications for Soil Sampling

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1 cm	5.3	8.5	20.7	12.8	9.6
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7 cm	1.6	2.1	2.0	3.0	2.2
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Seed Placed (20 kg P_2O_5/ha)

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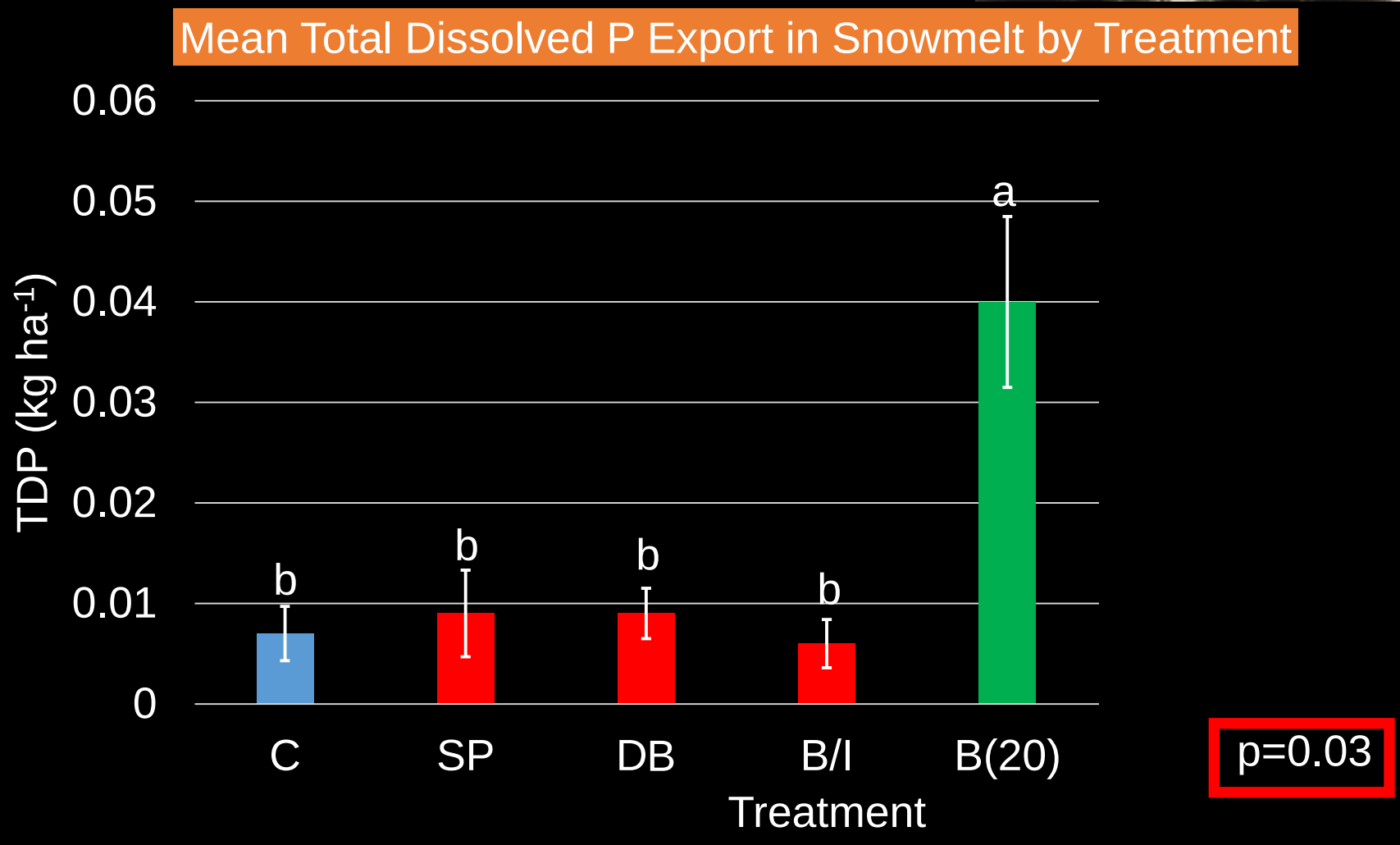
Enhanced P concentrations near soil surface from broadcast fertilizer application anticipated to promote off-site transport in runoff water.

Study 4: Simulated Snowmelt Runoff Experiment

Results



p=0.03

Discussion

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In-soil placement methods resulted in TDP export similar to the control treatment.

In-soil placement may be considered an effective strategy to limit off-site transport of applied P (Tabbara, 2003).

Conclusions

Regarding 4R Nutrient Stewardship, the Right Place and Right Rate were considered in these studies.

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In-soil placement of fertilizer P was an effective BMP to achieve greatest soybean yield response, while limiting potential off-site transport of applied P.

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In-soil placement of P fertilizer is agronomically and environmentally advantageous.

Questions?

Results

Fall 2014 Residual after-harvest STP concentrations in the surface (0-5 cm) depth at the Downslope position site.

	Treatment†							P Value
Method	C	SP	DB	B/I	B(20)	B(40)	B(80)	
	-----mg kg^{-1}-----							
MK P	10.9^{c}	12.9^{bc}	16.9^{abc}	17.3^{abc}	12.7^{c}	23.0^{ab}	25.8^{a}	0.0009
H_2O Sol. P	5.0^{c}	5.8^{c}	6.7^{bc}	8.1^{abc}	5.5^{c}	11.0^{ab}	11.9^{a}	0.0010
	-----µg cm^{-2}-----							
Resin P	0.4^{c}	0.6^{c}	0.7^{c}	1.0^{bc}	0.5^{c}	1.7^{a}	1.9^{a}	<0.0001

†A description the of the treatments is as follows: C: Control (no P); SP: Seed-placed (20 kg P_2O_5 ha^{-1}); DB: Deep band (20 kg P_2O_5 ha^{-1}); B/I: Broadcast with incorporation (20 kg P_2O_5 ha^{-1}); B(20): Broadcast (20 kg P_2O_5 ha^{-1}); B(40): Broadcast (40 kg P_2O_5 ha^{-1}); and B(80): Broadcast (80 kg P_2O_5 ha^{-1}).

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