Effect of application method on fate of phosphorus fertilizer

Jordan Wiens and Jeff Schoenau
Dept. of Soil Science
University of Saskatchewan
jordan.wiens@usask.ca

Justification

- Larger acreage farms = time constraints for seeding. Fertilizer placement looked at to save time.
    - Changes to placement strategy?
    - Changes to rate?
- Loss of P to water affects aquatic health
- Nature of P compounds in water affect P bioavailability in aquatic systems.

P fertilizer challenges

- Reactive
  - Readily adsorbed, precipitated in soil
  - Limits plant availability
- Immobility
  - Barrier to plant uptake, especially early season
- Mobility
  - Small amounts moved can be still be environmentally significant

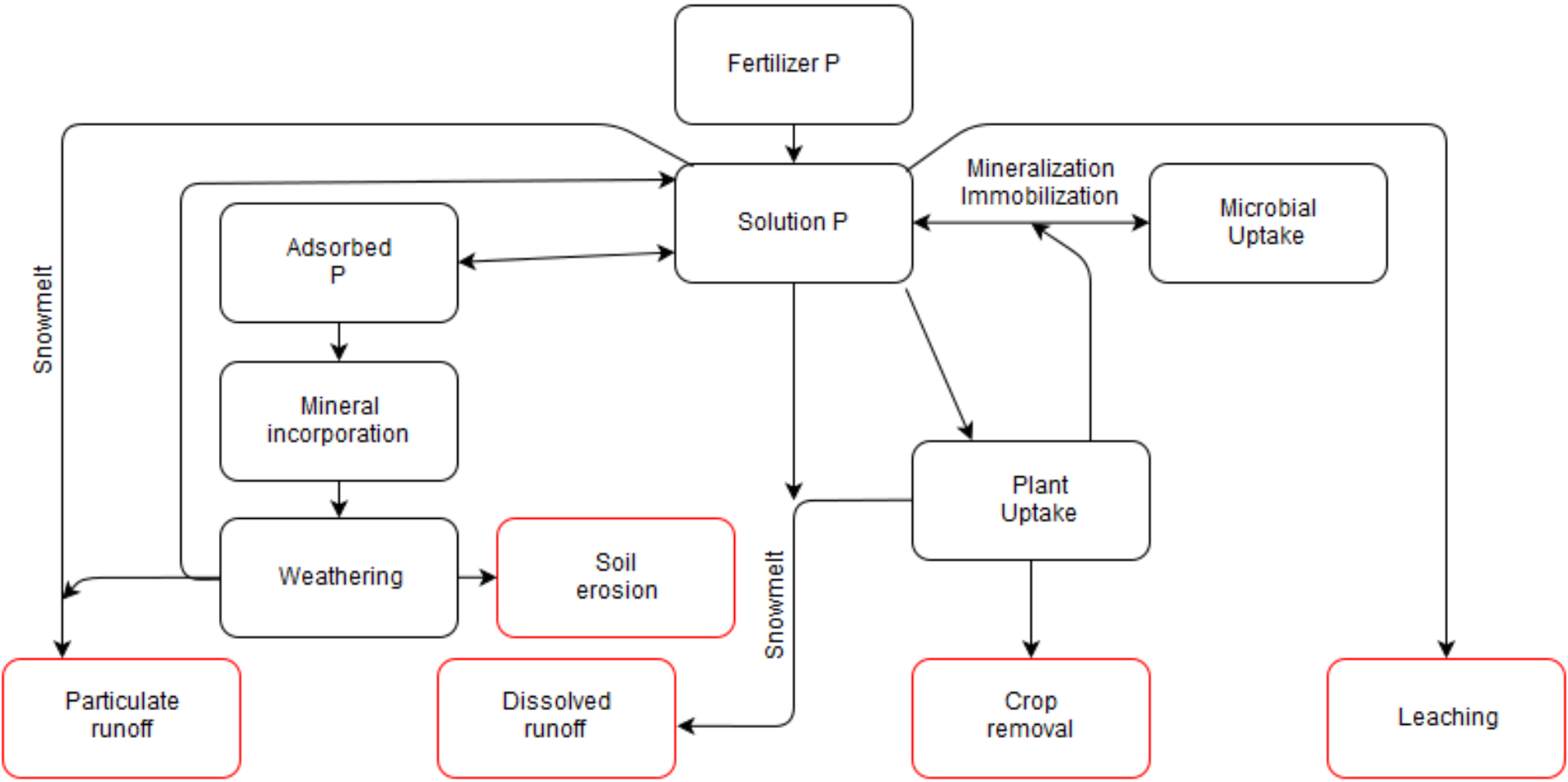


Figure 1: Fate of applied fertilizer P in agricultural ecosystems. Red boxes mark processes resulting in P export from the system.

Research question

How does P fertilizer placement influence:

1) plant and soil response to P fertilizer?

- yield, residual soil P

2) export of P in snowmelt runoff?

- amounts, forms

Design

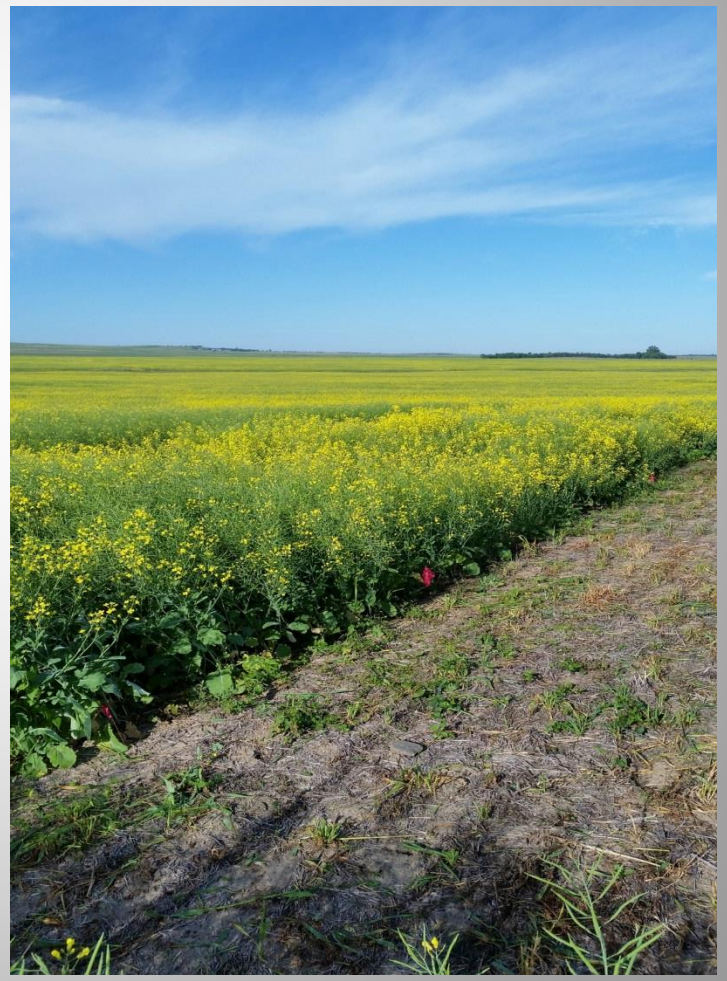
- P placement study treatments

Control	In-soil @ 20 kg P_2O_5 ha^{-1}	Surface Applied
Control-no P	Seed placed	Broadcast @ 20 kg P_2O_5 ha^{-1}
	Deep banded	Broadcast @ 40 kg P_2O_5 ha^{-1}
	Broadcast & Incorporated	Broadcast @ 80 kg P_2O_5 ha^{-1}

- Foliar P study
  - 20 kg P_2O_5 ha^{-1} total with varying proportion of P applied in foliar form
- Run-off
  - Slabs taken from one block in P placement study for P run-off amounts and forms

Site and Methodology

- Brown soil-climatic zone, Echo Association
- History: no-till, P fertilized
- RCBD field trials
- Single row seeder
  - Three rows per plot
- Soil and plant nutrient status
  - Extractions
  - Resin membrane
  - Digests
- Snowmelt runoff
  - Wet chemical assessment
  - ^{31}P NMR spectroscopy



Monolith P Mapping

One moment!

Table 1: Background nutrient values at P placement plots in Central Butte.

	Depth (cm)	Nutrient			
		NO_3	P	K	SO_4
			----------kg ha^{-1}----------		
Upslope	0-15	9	30	703	12
	15-30	7	7	299	30
Lowslope	0-15	9	32	684	14
	15-30	7	6	362	52

- Will limit response

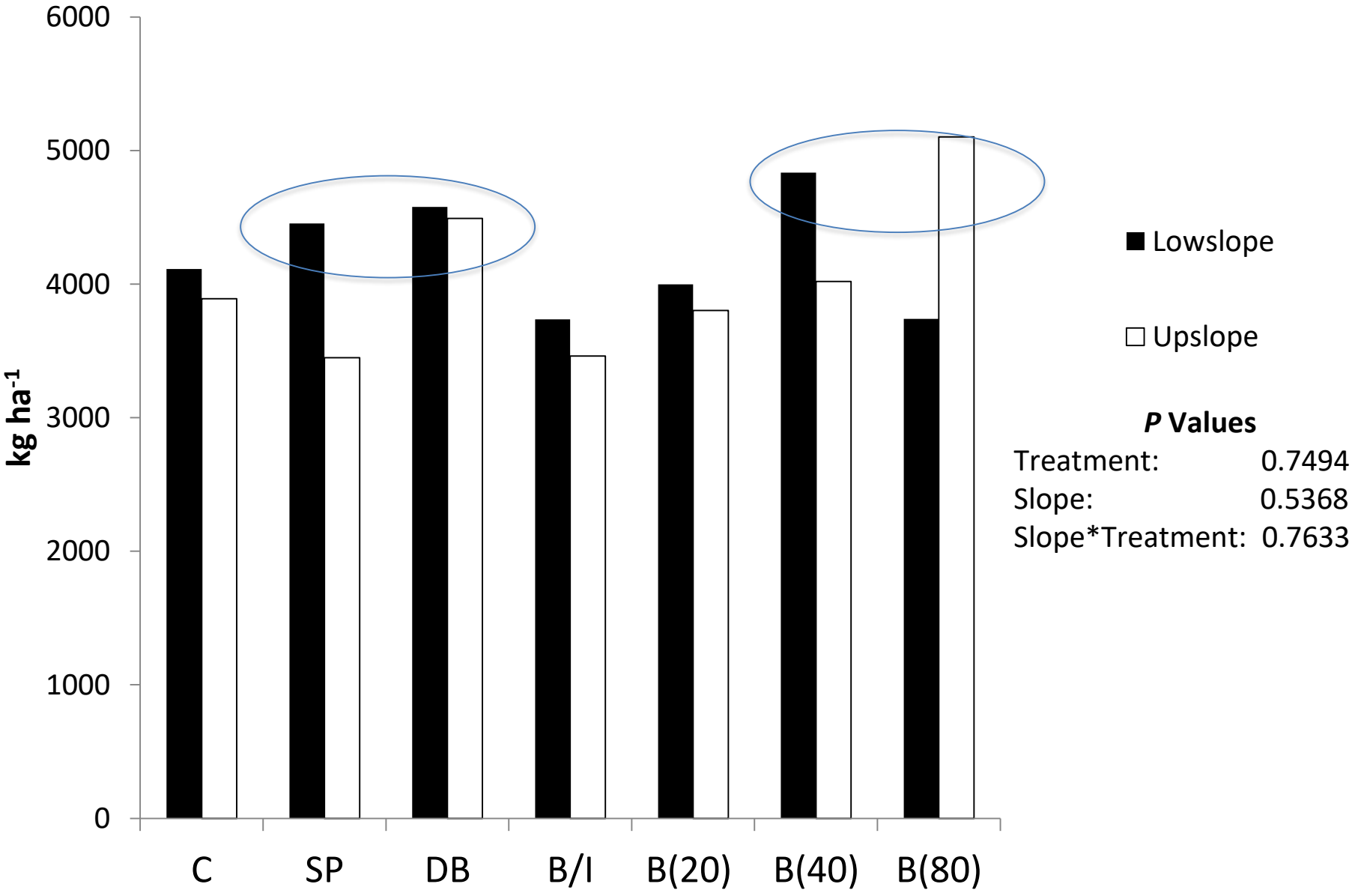


Figure 3. Canola grain yield at Central Butte, 2016. Growth conditions were much better in 2016 resulting in a much greater yield than the previous year.

Table 2: Central Butte upslope fall 2015 membrane exchangeable P.

	Treatment							
Depth (cm)	C	SP	DB	B/I	B(20)	B(40)	B(80)	*P* Value
	----------µg cm^{-2}----------							
0-15	0.63	0.50	0.58	0.34	0.44	0.57	0.84	0.0574
15-30	0.07	0.03	0.03	0.05	0.02	0.04	0.11	0.2096

Note: Treatments are abbreviated as follows: C=control, SP=seed placed, DB=deep band, B/I=broadcast and incorporated, B(20)=broadcast at 20 kg ha^{-1}, B(40)=broadcast at 40 kg ha^{-1}, B(80)=broadcast at 80 kg ha^{-1}. Treatments were applied at 20 kg ha^{-1} unless otherwise specified.

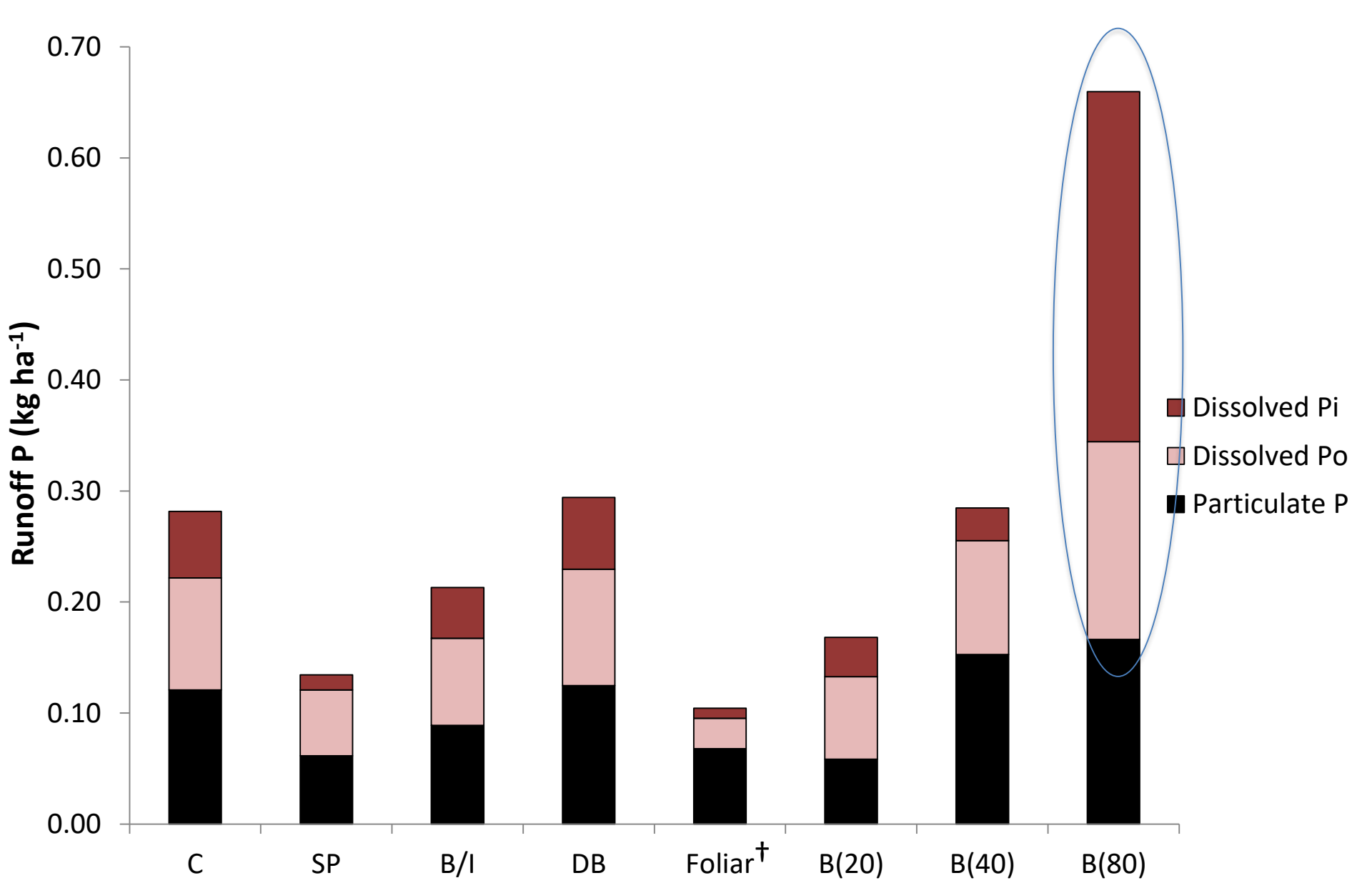


Figure 4. Runoff P in simulated runoff from intact slabs removed in fall 2016 from Central Butte upslope site.

† taken from different site, cannot be directly compared to other treatments

Table 3: Residual MK- P distribution in soil monolith after two successive treatments.
Units are µg P g^{-1} dry soil.

			Broadcast		
	----------Distance from seed row----------				
Depth	10 cm	5 cm	0 cm	5 cm	0 cm
1 cm	20.8	22.2	23.0	17.6	20.0
4 cm	14.1	13.8	12.9	12.3	12.7
7 cm	9.2	7.8	6.0	3.9	6.7
10 cm	4.6	3.3	3.9	3.1	4.7
			Seed placed		
	----------Distance from seed row ----------				
Depth	10 cm	5 cm	0 cm	5 cm	0 cm
1 cm	19.5	17.9	18.6	20.2	21.1
4 cm	18.8	19.6	28.0	21.1	18.5
7 cm	18.9	15.2	19.3	15.4	13.3
10 cm	7.0	7.1	12.3	11.2	8.1

Key Takeaways

- Factors influencing P response
  - Weather in western Canada can be more important factor affecting P response than placement method
  - Soil available P supply will affect response to fertilizer
    - Related to past management: no-till, history of P fertilization
- Broadcasting is not good for reducing P export
  - Broadcasting increases labile, mobile P at surface
  - High rates show more P in soluble reactive form

Acknowledgement

- Team Schoenau
  - Cory, Ranjan, Ben, Lindsey, Paul, Serena, Tom, Ryan, Blake, Jing, Noabur, Nancy, Katya, Wally, Raul
- Dr. Barb Cade-Menun (AAFC)
- Funding Agencies

Agriculture and
Agri-Food Canada