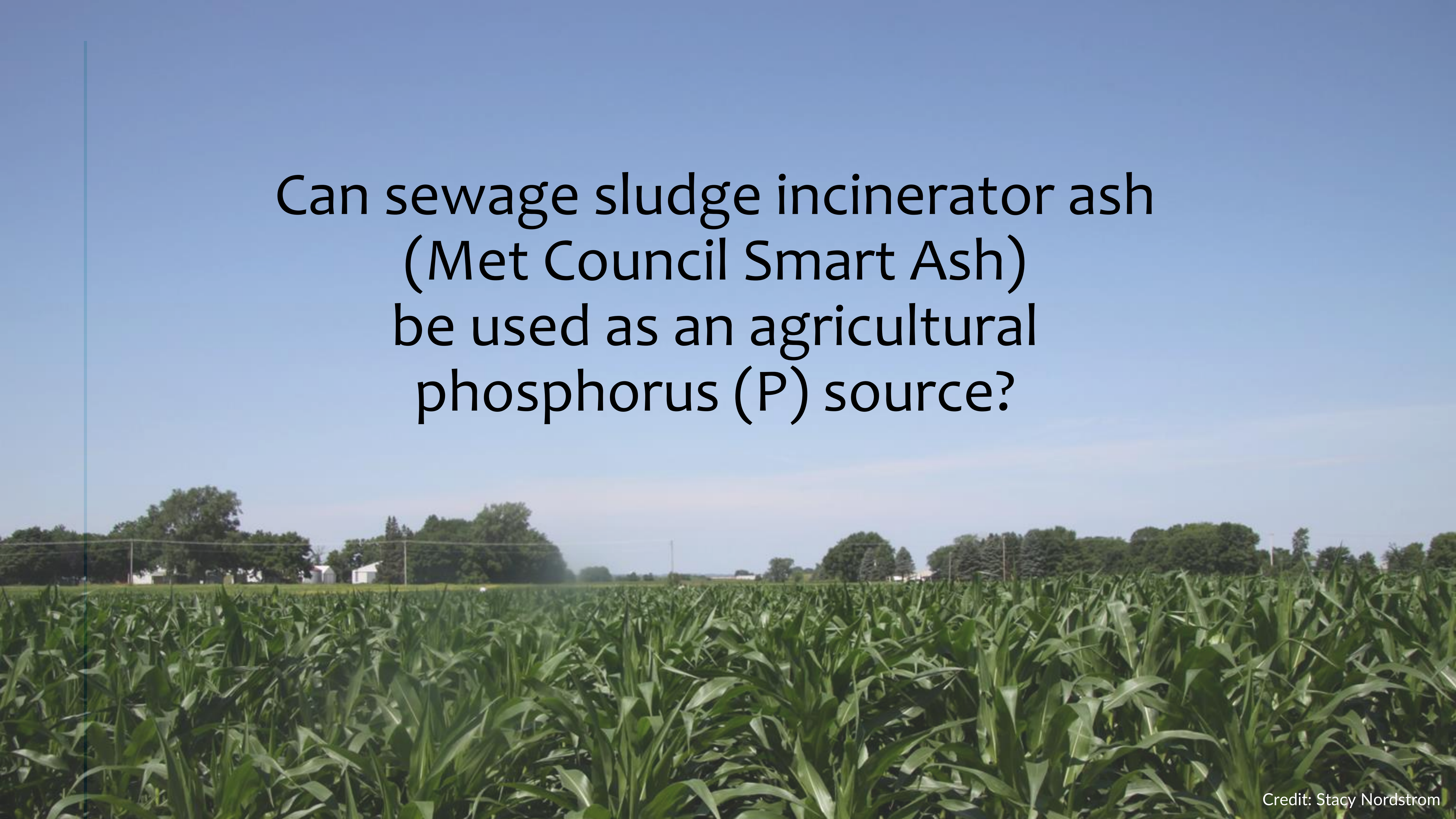
MET COUNCIL SMART ASH

Carl Rosen, Persephone Ma
Department of Soil, Water, and Climate | University of Minnesota

Can sewage sludge incinerator ash (Met Council Smart Ash) be used as an agricultural phosphorus (P) source?



Credit: Stacy Nordstrom

Questions

1) **Does this ash provide P?** How does it compare to other fertilizers?
2) What **other agronomic benefits** does this ash provide?
3) Are there **environmental risks** (chemical or microbiological) to its application?

Phosphorus

Credit: Jason Parker-Burlingham


Credit: Luiz Antonia Zanao Junior (IPNI)

Experimental Characteristics

- 2017 – 2019, in Rosemount, MN
- Field selection: low-medium available P
- P application rates:
  - 0 lb phosphate (P_2O_5) acre^{-1}
  - 40 lb P_2O_5 acre^{-1}
  - 80 lb P_2O_5 acre^{-1}
  - 120 lb P_2O_5 acre^{-1}
  - 160 lb P_2O_5 acre^{-1}
- Corn and soybean rotation

Year	East	West
2017	Corn	Corn
2018	Corn	Soybean
2019	Soybean	Corn

Phosphorus Sources

Sewage sludge incinerator ash (SSA)

- Provided by Met Council Environmental Services
- Added water for easy application

Triple superphosphate (TSP)

- Commercial, chemically-treated, phosphorus-only agricultural fertilizer

Biosolids (BS)

- Provided from Blue Lake Wastewater Treatment Plant
- Dried, pelletized, "exceptional quality" (Class EQ)

Struvite (STR)

- Magnesium ammonium phosphate
- Provided by Ostara

Credit: Ashleymarie Landsman

Element		**TSP**	**SSA**	**BS**	**STR**
NH_4-N	%	0.0	0.0	0.4	0.1
Total N		0.2	0.0	5.4	5.4
Available P		19.3	5.9	3.3	11.8
Total P		19.5	11.2	3.7	12.0
Soluble K		0.0	1.9	0.1	0.0
Total K		0.4	3.1	0.5	0.4

Phosphorus Source Elemental Concentrations

Element		TSP	SSA	BS	STR
Al	mg kg^{-1}	1,966.18	28,755.40	4,674.04	13.39
As		9.18	23.30	9.04	0.91
B		52.60	52.42	74.17	12.62
Ba		143.92	1,476.86	578.25	1.02
Be		1.71	0.38	0.23	0.23
Ca		218,431.23	133,075.88	39,199.01	2,394.61
Cd		22.22	7.05	0.78	0.23
Cl		226.30	997.31	7,051.20	940.86
Co		0.50	15.15	4.61	0.23
Cr		217.62	342.17	42.41	0.23
Cu		40.11	1,949.18	835.95	0.91
Fe		1,952.82	31,667.44	52,077.35	343.12
Hg		0.01	1.80	0.38	0.00
Li		2.81	9.45	2.92	0.45
Mg		6,050.41	34,121.06	16,278.22	146,075.05
Mn		39.36	7,762.52	2,328.26	367.72
Mo		10.50	38.85	14.75	0.23
Na		3,827.17	5,474.14	2,090.23	125.89
Ni		45.46	124.20	23.80	0.45
Pb		4.84	100.50	21.89	0.68
Rb		22.40	26.00	22.40	22.40
S		16,055.47	7,162.53	11,053.76	69.57
Se		6.11	19.00	8.08	2.41
Si		2,022.59	3,496.64	4,181.42	31.03
Sr		943.48	244.43	127.82	1.30
Ti		88.59	1,736.10	1,147.65	1.24
V		262.56	31.99	13.68	1.81
Zn		480.34	3,395.96	1,124.81	4.73

Concentration versus Loading Rates

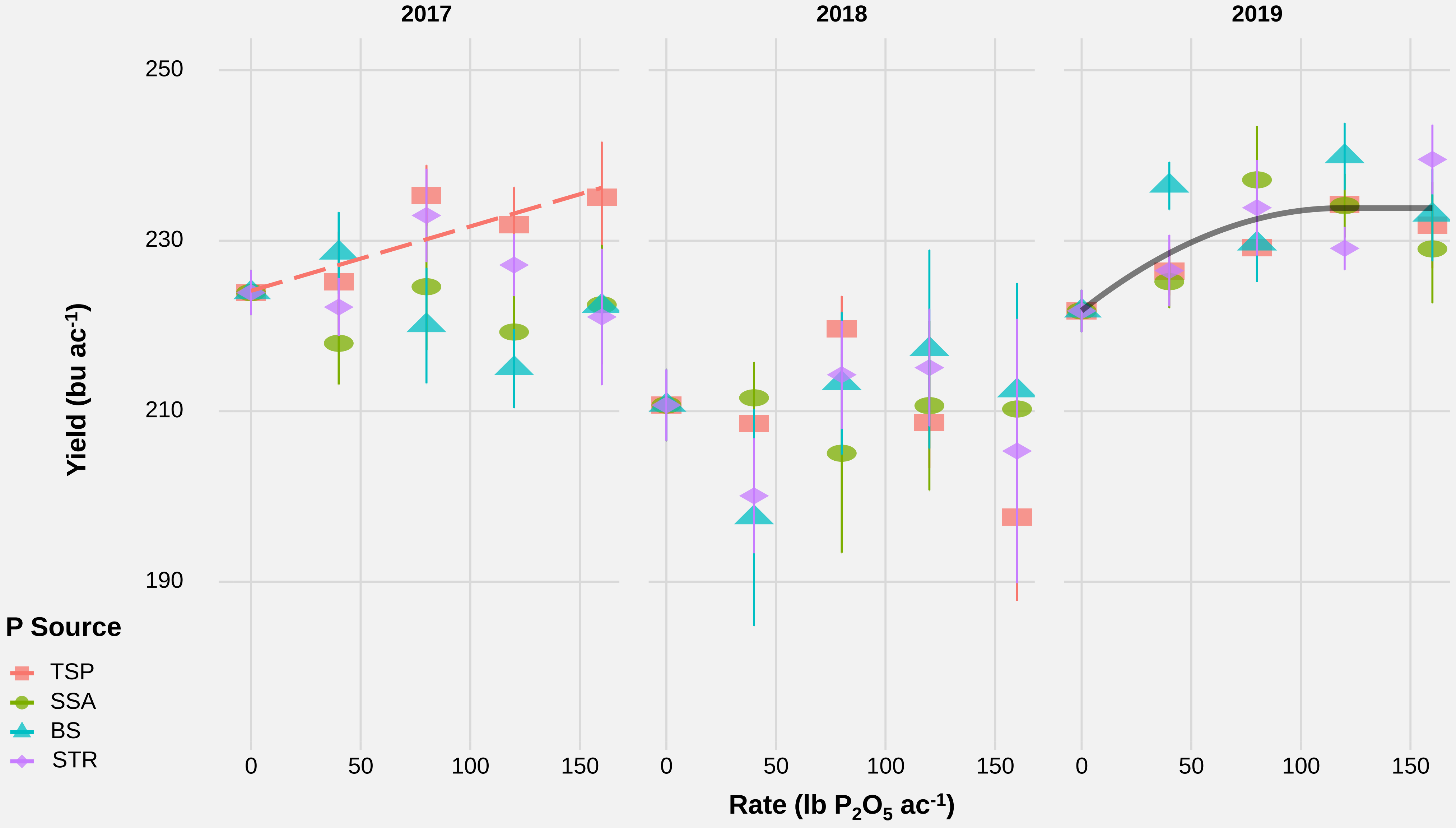
Concentration ($mg\ kg^{-1}$)				
	TSP	**SSA**	**BS**	**STR**
Copper	40.11	1,949.18	835.95	0.91
Zinc	480.34	3,395.96	1,124.81	4.73

Loading Rate* ($g\ ac^{-1}$)					
	TSP	**SSA**	**BS-P**	**BS-N**	**STR**
Copper	3.28	481.05	400.11	2,883.89	0.24
Zinc	39.31	838.11	538.38	3,880.44	0.63

* when applied at 80 lb P_2O_5 per acre or 180 lb N per acre for BS-N.

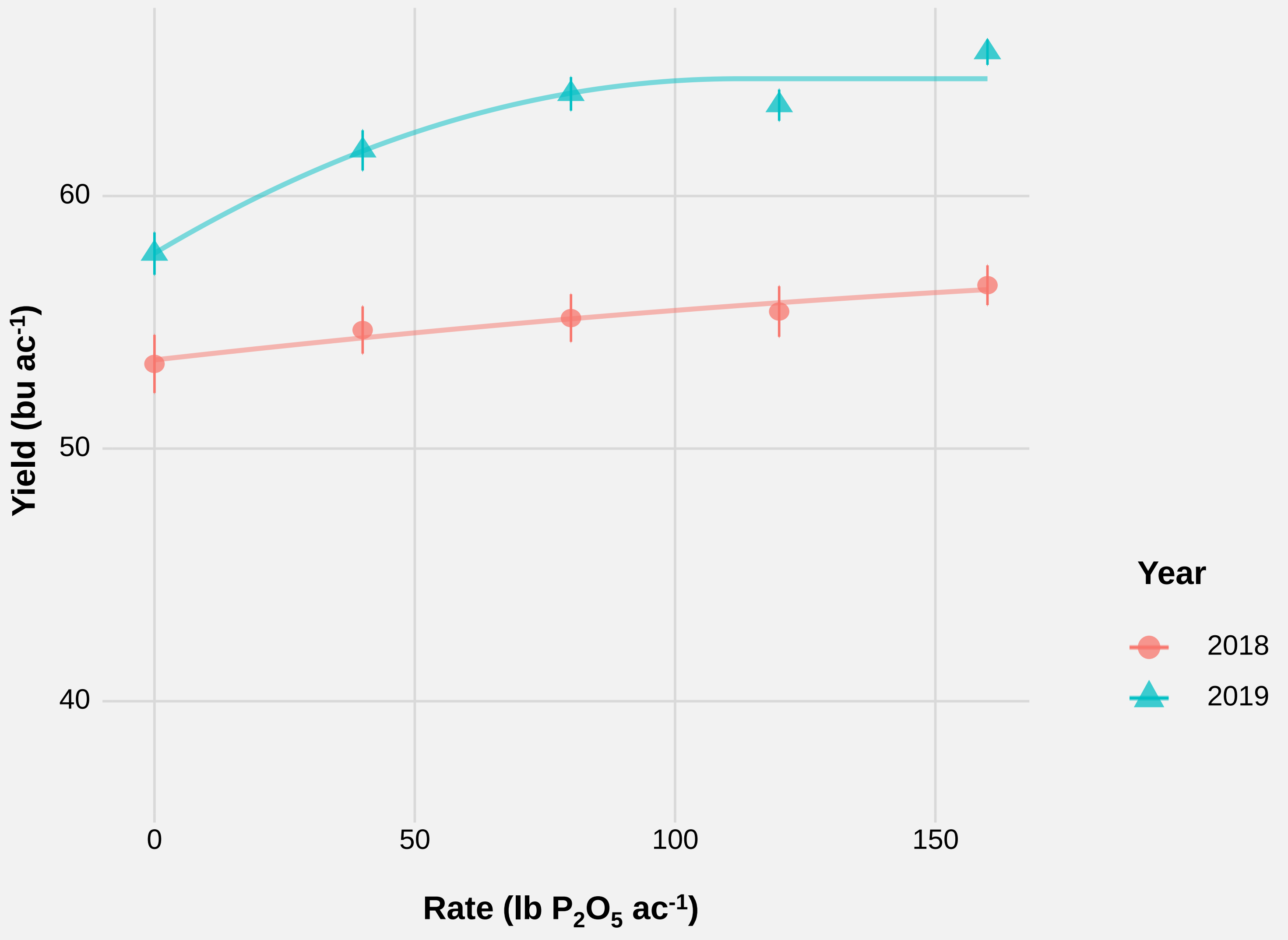
Credit: Stacy Nordstrom

Corn Yield

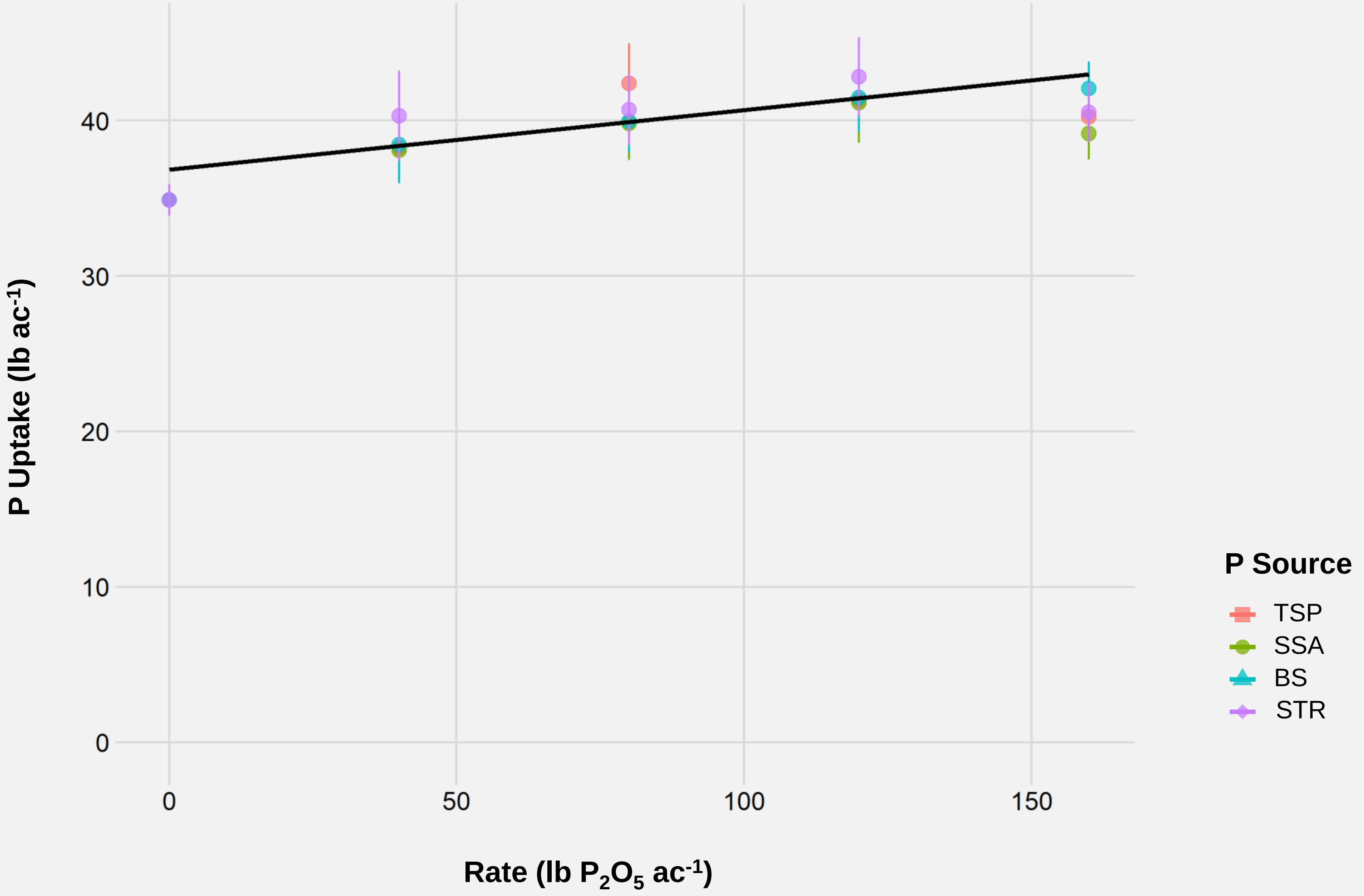


2017
2018
2019
250
230
210
190
Yield (bu ac-1)
0
50
100
150
Rate (lb P2O5 ac-1)
P Source
TSP
SSA
BS
STR

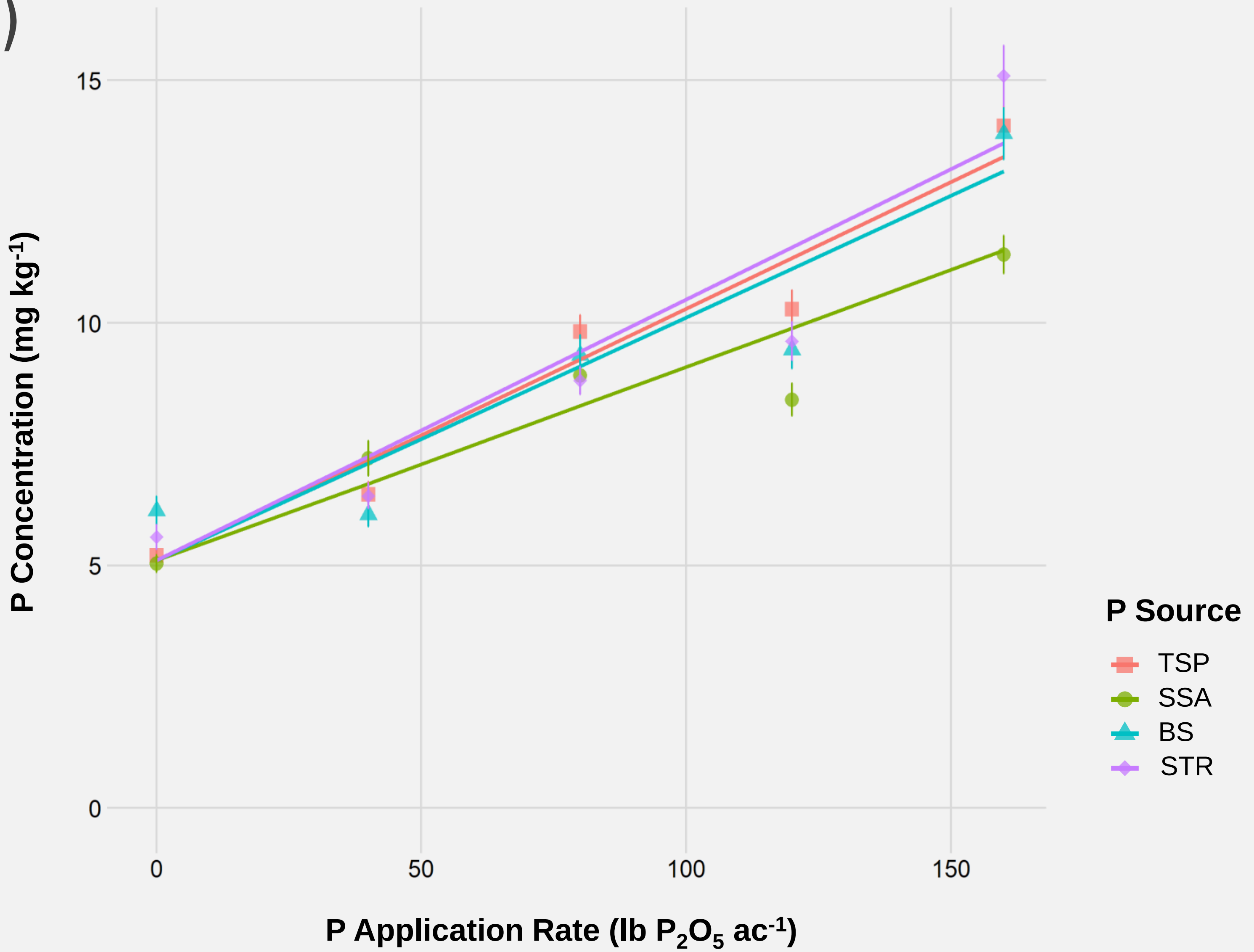
Soybean Yield



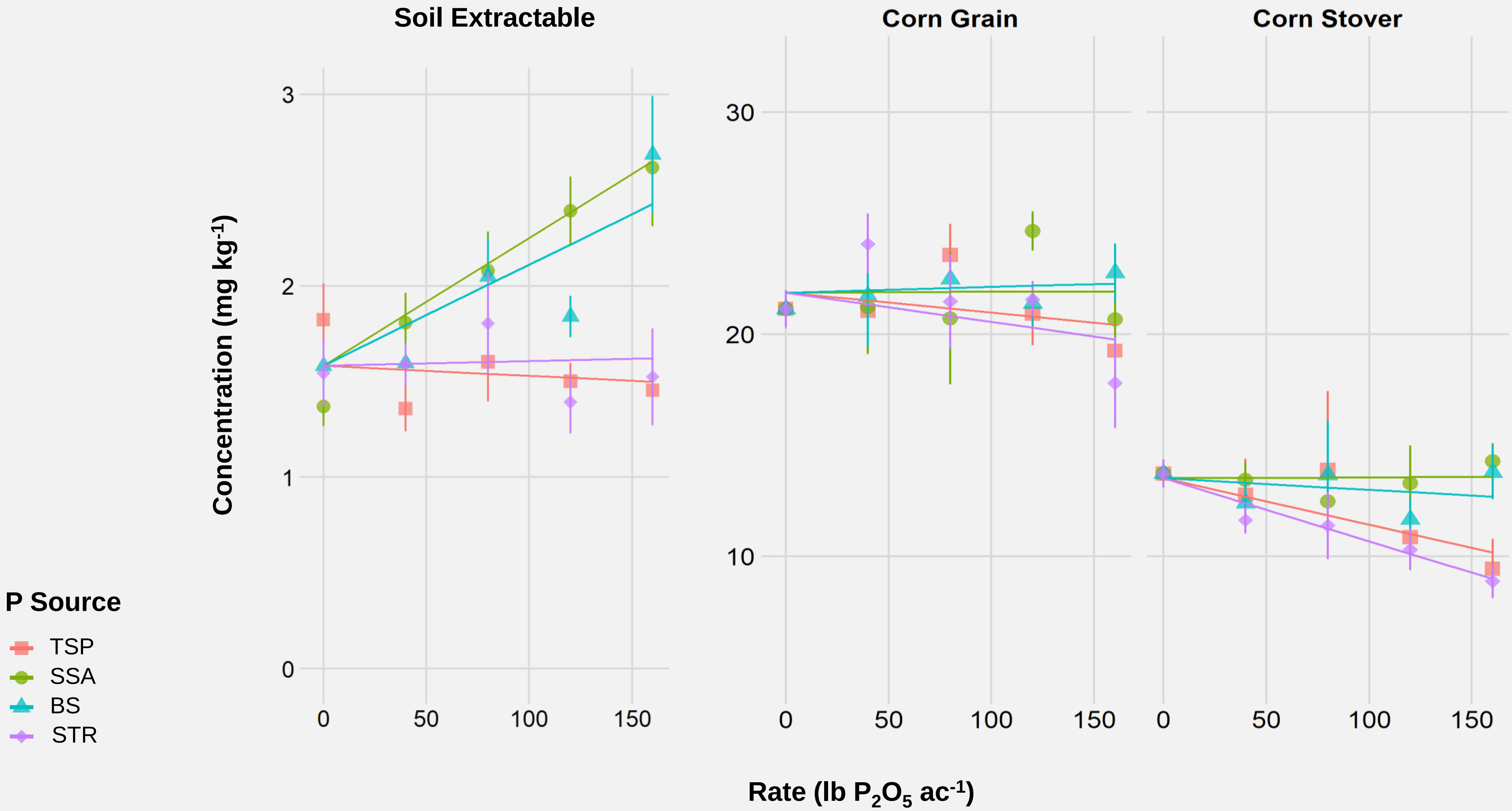
P Uptake in Corn Grain
(3-year average)



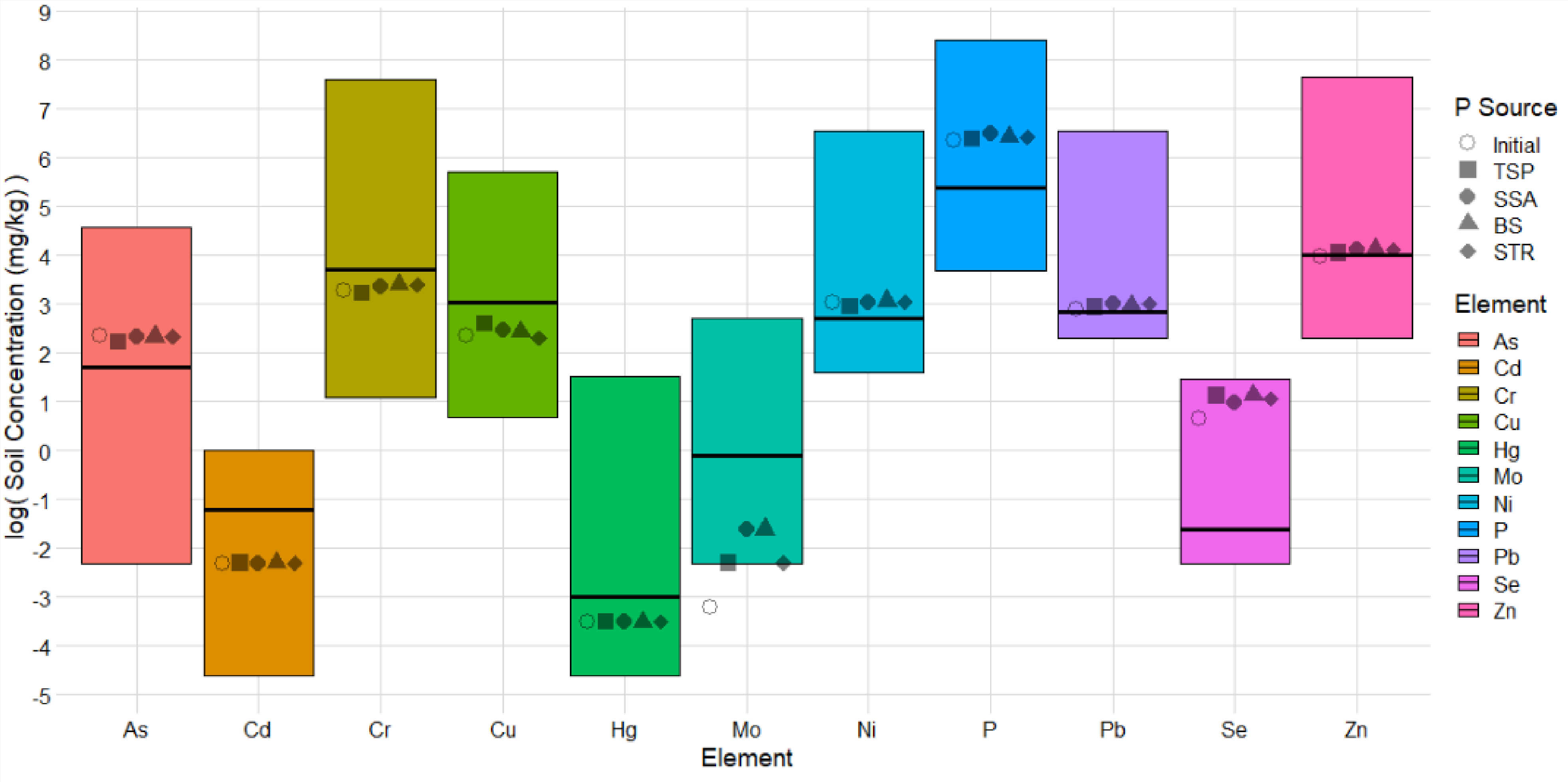
Available Soil P (Olsen-P)
(3-year average)



Zinc (3-year average)



Elements of Concern



Fungi

2017 Initial
2017 EOS
2018 EOS
2019 EOS
Fungi Relative Abundance (%)
100
75
50
25
0
CON_0
TSP_1
SSA_1
BS_1
STR_1
TSP_2
SSA_2
BS_2
STR_2
Treatment
Phylum
Aphelidiomycota
Ascomycota
Basidiobolomycota
Basidiomycota
Calcarisporiellomycota
Chytridiomycota
Glomeromycota
Kickxellomycota
Monoblepharomycota
Mortierellomycota
Mucoromycota
Olpidiomycota
Other
Rozellomycota
unidentified
Zoopagomycota

Conclusions

- **SSA increases P in soil** and appears to provide a **slow-release form of P** for plant uptake.
- **SSA provides Cu and Zn** at appropriate concentrations for plant nutrition.
- If applied at agronomic rates, **SSA amendment does not increase concentrations of elements of concern** to any biologically significant level.
- **SSA does not affect microbial communities** any differently than commercial P sources.

Credit: Stacy Nordstrom

Recommendations

1. Product development, e.g. pelletization.
2. On-farm testing under realistic growing conditions in a variety of soil types and crops.
3. Periodic monitoring of soil P tests and soil concentrations of elements of concern.
4. Development of best practices for SSA application that include guidelines for analytical testing of available P, soil testing, and SSA application.

Acknowledgments

- Metropolitan Council Environmental Services
- UMN College of Food, Agricultural, and Natural Resource Sciences
- UMN Graduate School
- Baker Family Foundation
- Matt McNearney and Rosen Lab Field Crew
- Thor Sellie and Soil, Water, and Climate Field Crew
- Kimon Karelis and Rosemount Research and Outreach Field Crew
- UMN Research Analytical Lab

QUESTIONS?

Carl Rosen (rosen006@umn.edu)
Persephone Ma (phma@umn.edu)

Credit: Stacy Nordstrom