

FRST P and K Response Trials at Penn State - 2021

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Overview of Trials

- One site of K response plots
 - 0, 25, 50, 100, 200 lbs/ac K_2O as muriate of potash
 - Broadcast application, no incorporation
 - No-till soil and crop management
- Two sites of P response plots
 - 0, 20, 40, 80, 160 lbs/ac P_2O_5 as triple superphosphate
 - Broadcast application, no incorporation
 - 1 site: no-till management
 - 1 site: tillage prior to crop planting and fertilizer application
- Baseline soil samples collected per block in March
 - 0-10cm, 0-15cm, 0-20cm x 15 cores per block
 - Mehlich 3 soil test extraction at PSU AASL
- Soybeans planted at all three sites in late May, 30" row spacing
- Fertilizer treatments applied within 1 week of planting
- Fertilizer plots 6 rows wide x 35' or 45' long
- In K trials applied flat rate of P, in P trials applied flat rate of K



Penn State Fertility Recommendations

- Mehlich 3 Soil Test Optimum Range for soybeans and most other grain crops
 - 100-150 mg/kg K
 - 30-50 mg/kg P
- Recommended soil sampling depth for annual crops: 0-6" or 8"
- Build and Maintain Approach to Fertilizer Recommendations
 - Build: Greater than crop removal fertilizer rate below the critical soil test level
 - Maintain: Crop removal fertilizer rate at the critical soil test level
 - Drawdown: Declining rate of fertilizer as soil test increases within the optimum zone, zero fertilizer at the top of the optimum range and above

Phosphorus Recommendation (lb P₂O₅/A):
 (Optimum soil test P: 30 - 50 ppm)

Soil test P (ppm)	Yield Goal (Bu/A)				
	40	50	60	70	80
0	120	130	140	150	160
5	110	120	130	140	150
10	90	100	110	120	130
15	80	90	100	110	120
20	70	80	90	100	110
25	50	60	70	80	90
30	40	50	60	70	80
35	30	40	50	50	60
40	20	30	30	40	40
45	10	10	20	20	20
50	0	0	0	0	0

Critical Level

Optimum Range

Crop Removal Fertilizer Rate (1 lb P₂O₅/bu soybean)

Potassium Response Trial

Soil Properties

Sample Depth (cm)	pH (1:1 H ₂ O)	Mehlich 3 P (mg/kg)	Mehlich 3 K (mg/kg)	CEC (meq/100g)	Organic Matter (%)	Sand (%)	Silt (%)	Clay (%)
0-10	6.9	48	102	9	2.4			
0-15	6.6	43	92	10	2.2			
0-20	6.6	39	81	9	2.1	41	32	26

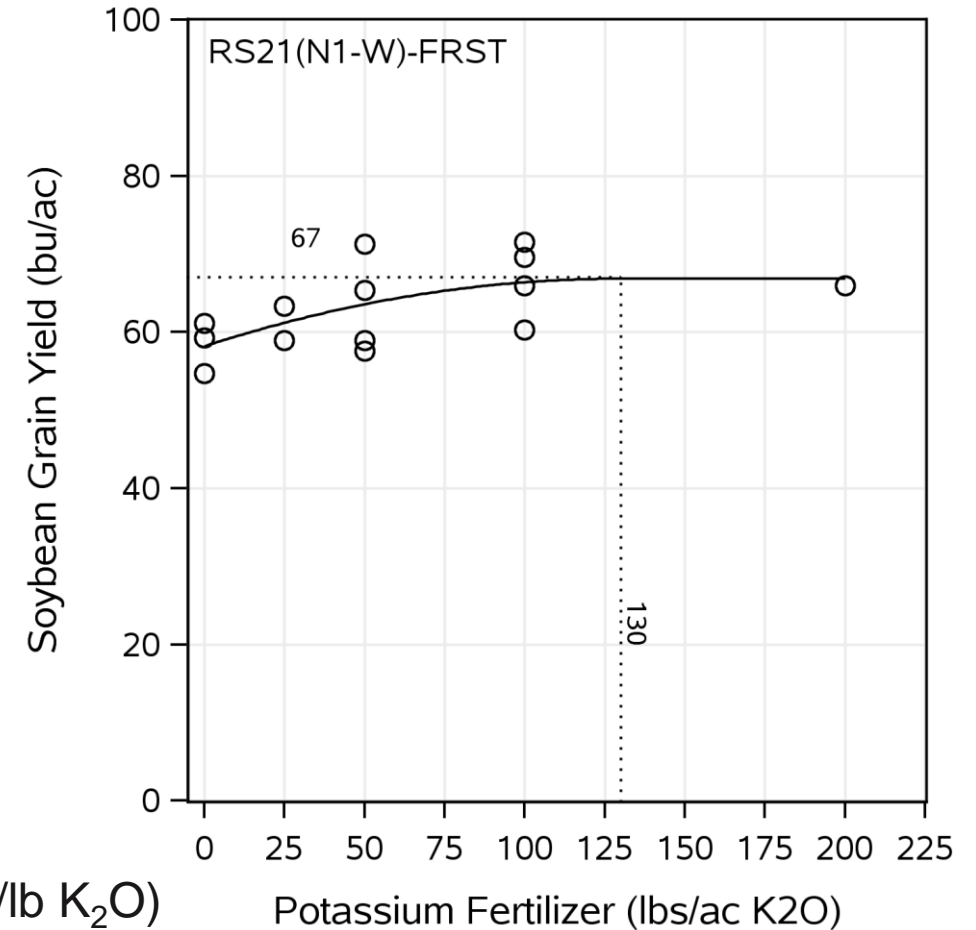
Results

- Groundhog feeding affected several plots
- ANOVA F-test, P=0.02
 - 50, 100 lbs/ac rates > untreated
- Quadratic-plateau response curve fit
 - $y = 58 + 0.13x - 0.00052x^2$
 - First-order term, P=0.09
 - Second-order term, P=0.38

Discussion

- Economic optimum K₂O rate = 88 lbs/ac (\$13.60/bu beans, \$0.52/lb K₂O)
- Crop Removal K₂O = 94 lbs/ac
- PSU AASL K₂O recommendation = 110-120 lbs/ac

Yield Response



Phosphorus Response Trial #1 (Tilled Site)

Soil Properties

Sample Depth (cm)	pH (1:1 H ₂ O)	Mehlich 3 P (mg/kg)	Mehlich 3 K (mg/kg)	CEC (meq/100g)	Organic Matter (%)	Sand (%)	Silt (%)	Clay (%)
0-10	7.0	53	148	9	1.8			
0-15	7.0	52	144	8	1.7			
0-20	6.8	49	136	9	1.7	32	42	25

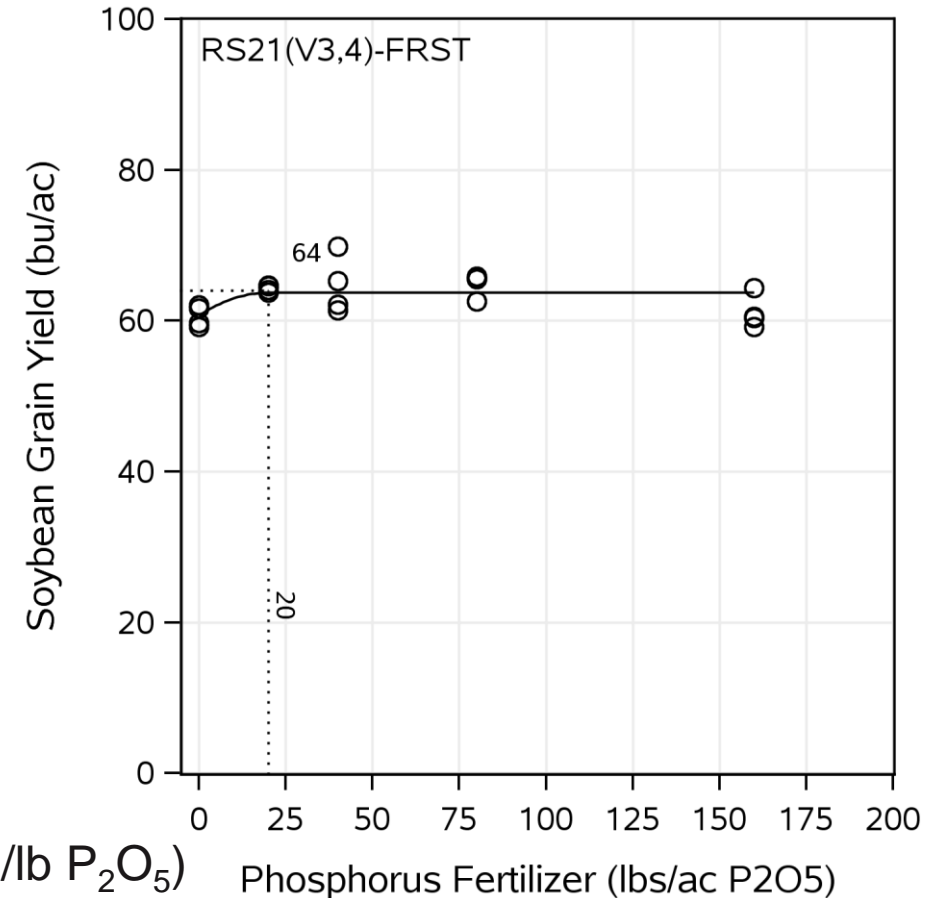
Results

- ANOVA F-test, P=0.04
 - 20, 40, 80 lbs/ac P₂O₅ rates > untreated
 - 4 bu/ac yield increase
- Quadratic-plateau response curve fit
 - Plateau reached at first P addition level

Discussion

- ROI @ 20 lbs/ac P₂O₅ rate = \$38.40/ac (\$13.60/bu beans, \$0.80/lb P₂O₅)
- PSU AASL P₂O₅ recommendation = 0-20 lbs/ac
- Crop Removal P₂O₅ = 64 lbs/ac

Yield Response



Phosphorus Response Trial #2 (No-Till Site)

Soil Properties

Sample Depth (cm)	pH (1:1 H ₂ O)	Mehlich 3 P (mg/kg)	Mehlich 3 K (mg/kg)	CEC (meq/100g)	Organic Matter (%)	Sand (%)	Silt (%)	Clay (%)
0-10	6.6	35	160	11	2.1			
0-15	6.7	32	136	12	2.1			
0-20	6.7	30	120	12	2.1	20	44	36

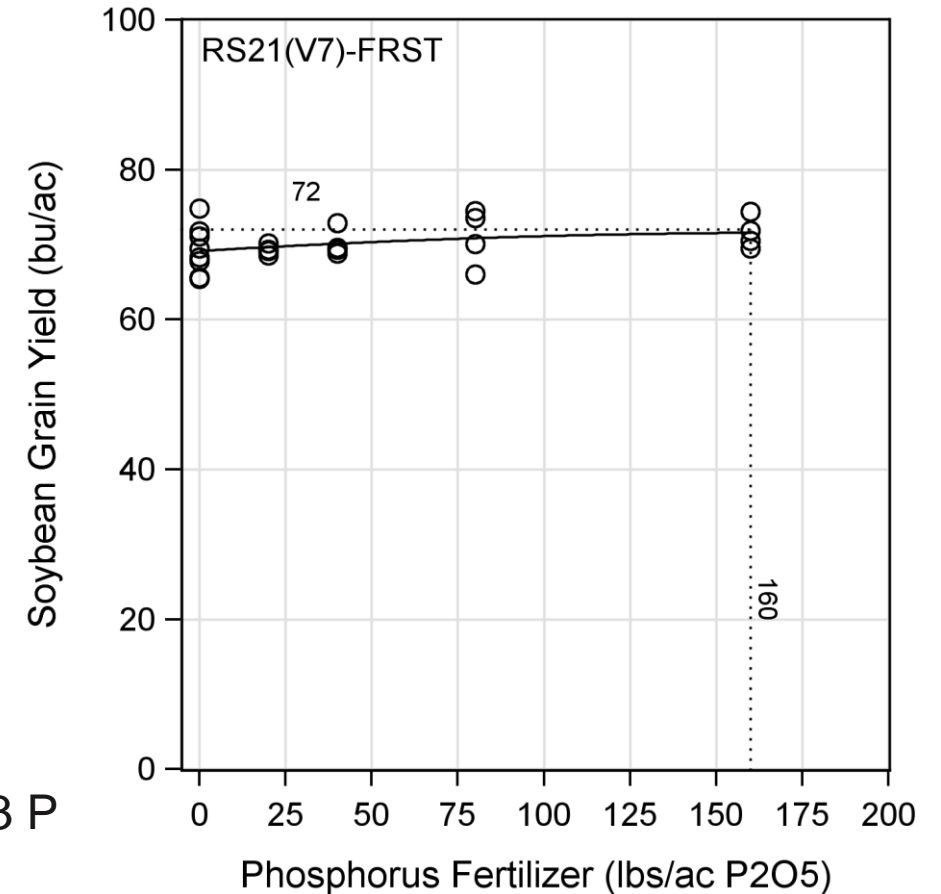
Results

- ANOVA F-test, P=0.62
- Quadratic-plateau response curve fit
 - First-order term, P=0.40
 - Second-order term, P=0.70
- Site was unresponsive to P additions

Discussion

- Despite lower soil test P than site 1, site 2 was unresponsive
 - Consistent with existing critical soil test P level of 30 mg/kg M3 P
 - Mycorrhizal effect in no-till soils?
- PSU AASL P₂O₅ recommendation = 70 lbs/ac
- Crop Removal P₂O₅ = 72 lbs/ac

Yield Response



Questions?